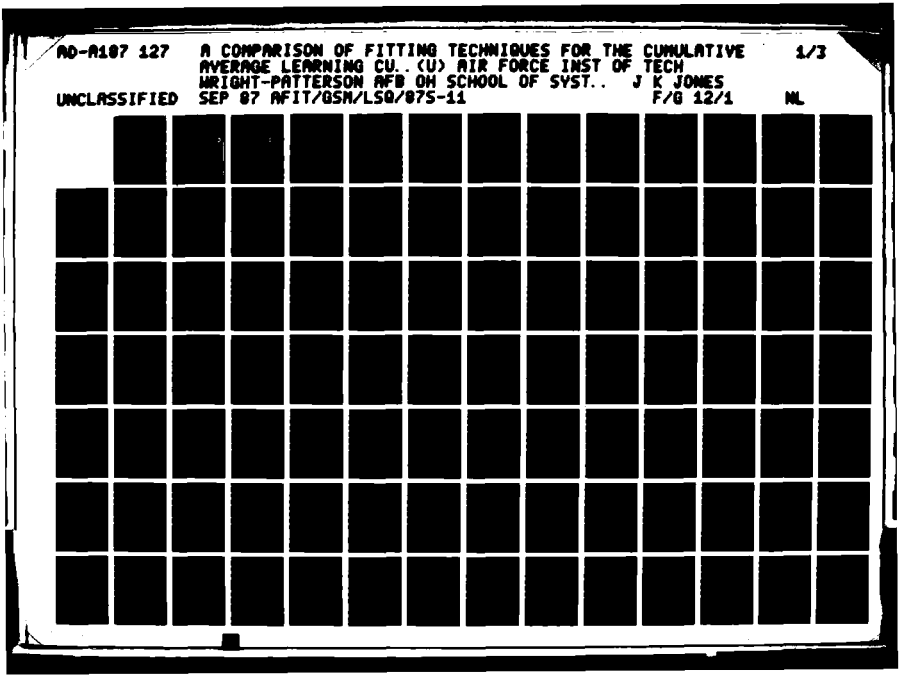
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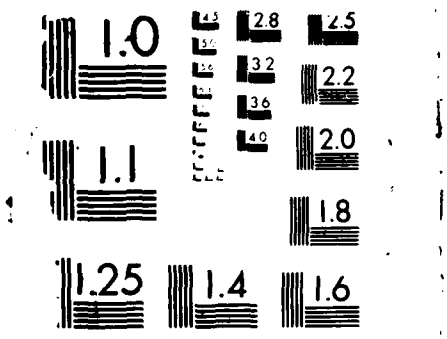

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A COMPARISON OF FITTING TECHNIQUES FOR THE CUMULATIVE AVERAGE LEARNING CURVES WITH HISTORICAL LOT COST DATA

THESIS

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AFIT/GSM/LSQ/87S-11

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THESIS

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Systems Management

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John K. Jones

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Abstract

The technique used to fit cost data to the cumulative average learning curve can have an impact on the accuracy of the estimates provided. This research tested two specific fitting techniques, the elementary technique (ET) and the Calot technique, in an attempt to determine which technique provides the greater accuracy when used to fit historical lot cost data to the cumulative average learning curve. Both techniques were evaluated on there ability to fit total lot costs and predict last lot costs.

The ET and Calot fitting techniques were both used to fit the historical lot costs for 66 systems to the cumulative average learning curve. A comparison of the two techniques indicates that Calot estimates total lot costs with greater accuracy more frequently and with a significantly lower standard error than the ET technique. Calot also demonstrated the ability to estimate the last lot costs more accurately more frequently than 50% of the time.

A COMPARISON OF FITTING TECHNIQUES FOR THE CUMULATIVE AVERAGE LEARNING CURVES WITH HISTORICAL LOT COST DATA

I. Introduction

General Issue

Learning curve analysis is widely used throughout the Air Force for estimating recurring production costs. There have been many derivations of learning curves generated and used throughout the government and public industry. Many of the learning curve formulations have been developed by the aircraft industry. The Boeing and Northrop curves are among the commonly used formulations. The different formulations generally fall into two types of learning curve models; these being the unit curve and the cumulative average curve. While both of the formulations have successfully been used, it has been demonstrated that they will provide different estimates when used with identical input data. This results from the differences in the formulations. What may be less known is that different estimates may arise with identical inputs when using the cumulative average formulation. This results from the different algorithms used to fit the cumulative average formulation. Many variations exist in the area of cumulative average

curves. This research will attempt to evaluate which formulation of the cumulative average curve is generally the most appropriate when used for estimating recurring production costs for Air Force acquisitions.

Specific Problem

With the availability of different algorithms to fit the cumulative average curves, many commercial organizations have been able to adapt a formulation which replicates their own efforts when used with past cost history. Air Force activities must deal with many various contractors and are therefore unable to come up with a model that always fits the organization.

Research Objectives

There have been studies performed which indicate that differences exist between the cost estimates provided by the different cumulative average curves. These studies have often been performed using cost history from a single program or hypothetical data. This research study will attempt to identify the formulation of the cumulative average curve which best reflects the actual cost history from many different Air Force programs. This study will focus on two specific algorithms of the cumulative average curve. One uses lot end points while the other uses lot plot points for fitting of the data.

Literature Review

This section will introduce some information on the background of learning curve analysis. It covers the origin, basic concepts, the unit curve model, the cumulative average model, some basic differences between the two models, and a demonstration of the differing results obtained by fitting the two cumulative average formulations.

Origin. T.P. Wright began his studies of learning curve analysis in 1922. His findings were first published in 1936 by the Journal of the Aeronautical Sciences. In "Factors Affecting the Cost of Airplanes," Wright demonstrated that there was a consistent decrease in the direct man-hour cost associated with the production of aircraft. This decrease in labor cost occurred at a decreasing rate as the number of aircraft produced in sequence increased (14:122). Wright was further able to show that the decrease occurred in a predictable manner.

Based on the direct man-hour data in his study, Wright found that as the total quantity of units produced doubled, there was an 80 percent reduction in the average labor cost (14:124). Wright's study has led to two industry standards. "It is the origin of the well-known '80 percent curve' found in industry and planning (3:17)." A second industry standard has led to the most commonly accepted definition of the unit learning curve. "As the total quantity of units produced doubles, the cost per unit decreases by some constant

percentage (13:6)." This constant percentage is known as the rate of learning. An example of a unit learning curve with an 80 percent rate of learning would reflect that the cost of the second unit would be 80 percent of the cost of the first unit and that the cost of the fourth unit would be 80 percent of the cost of the second unit, and so on. The cumulative average curve is based on the same concept of units doubling but deals with the average unit cost through that unit.

Basic Concepts. Learning curves are based on the theory that as an individual continues to perform a repetitive task, his performance will improve. Due to the repetitive nature of the job, the laborer will make mental and physical adjustments which will allow him to complete the task in a more efficient manner. This increased efficiency is attributed to learning. It is this learning that often leads to an overall increased efficiency throughout a production line which produces a reduction in cost or labor hours. This reduction can often be quantified with learning curves.

Many factors in an organization influence the overall efficiency that it achieves. Much of the overall learning is attributable to the direct workers. This learning is influenced by many factors such as morale, worker environment, engineering changes, design fixes and simplification, and many management controlled innovations (10:2). All of

these factors contribute to an overall rate of learning for the organization. It is this rate of learning which is used in learning curve analysis to predict future cost. Due to the many factors that contribute to the overall learning rate, learning curves have been called by many various names. Cost improvement curves, progress curves, cost-quantity relationships, cost or time reduction curves, and experience curves have all been used at one time or another to describe learning curves (1:7-3). Many curves, such as the Boeing, Crawford, Northrop, and Wright curves, have been named after the men or companies who developed them. "All of these names refer to one of two mathematical models generally agreed to best describe how cost or labor hours decrease as the quantity of the item being produced increases (1:7-3)." Two basic models serve as the basis for these other models; these being the unit curve and the cumulative average curve.

Unit Curve Model. The unit curve model is represented by the formula:

$$Y = A * X^{**}b \qquad (1)$$

where Y = predicted unit cost for unit # X
A = cost of the first unit
X = unit number
b = a constant that depends on the learning rate (b = log r / log 2)
r = learning curve rate, as a decimal

(10:18)

The cost represented by variables Y and A may be expressed in dollars or labor hours. In most cases, these variables will reflect direct labor hours since they can be used to measure costs regardless of the time period or different wage rates. The variable r is often referred to as the slope of the learning curve and for all practical purposes will fall in the range from 50 percent to 100 percent (10:18).

The following example will demonstrate the unit learning curve formula for the estimation of eight units. The example is based on a 90 percent learning curve.

Let A = 1000 (cost of first unit in direct labor hours)
let r = .90 based on the 90 percent learning curve
then b = -.152 (b is always negative to reflect a constant rate of decrease)
if X = 2 (the number of the unit being predicted)
then Y = 900 (the cost of unit 2)

Table I provides the computed unit costs for units 1 through 8. As the quantity produced doubles, the unit cost decreases by 10 percent as reflected by the 90 percent learning curve rate.

Table I

Unit Cost Based on a 90 Percent Learning Curve

Units Produced	Unit Cost	90% Learning Rate
1	1000	
2	900	(Notice that as the quan-
3	846	tity doubles from unit 2
4	810	to unit 4, the unit costs
5	783	decrease from 900 to 810)
6	762	
7	744	
8	729	

Cumulative Average Model. The model originally presented by T.P. Wright is the cumulative average model. The formulation of the model is essentially the same as that of the unit formulation. The primary difference is that the cost reflected in the cumulative average model represents the average cost of units 1 through X. This model is stated as:

$$\bar{Y} = A * X^{**}b \qquad (2)$$

where $\bar{Y}$ = the average cost of units 1 through X
A = the cost of unit one
X = cumulative production unit
b = a constant that depends on the learning rate (b = log r / log 2)
r = learning curve rate, as a decimal

(10:18)

Computed values for the cumulative average model are the same as those presented in Table I, but the costs are representative of the cumulative average unit cost for units 1 through X.

It is often necessary for cost estimators and cost analysts to estimate the cost of an individual unit instead of the average cost through that unit. Therefore, it is often necessary to convert cumulative average costs into unit costs. The following formula can be used to convert cumulative average costs through unit X into the cost of unit X:

$$Y = A\,[X^{**}(b+1) - (X-1)^{**}(b+1)] \qquad (3)$$

where Y = the unit cost for unit # X
all other variables have been defined in the cumulative average model

(4:7)

Table II provides the cumulative average cost for units 1 through 8 and the converted unit cost for units 1 through 8. Recall the learning curve slope is 90%, i.e., b = -.152.

Table II

Unit Cost as Converted from Cumulative Average Cost

Unit Number	Cumulative Average Cost for X Units	Unit Cost of X
1	1000	1000
2	900	800
3	846	738
4	810	702
5	783	675
6	762	657
7	744	636
8	729	624

Predicting Future Cost. Cost analysts have frequently encountered the problem of predicting future cost based on an existing production run. This requires the cost analyst to derive the learning curve formula from current production cost data.

An approximation of the learning curve formula is often derived by plotting the known cost on log-log graph paper. When plotted on log-log graph paper, a straight best fit line may be fitted through the data by visual inspection and future costs may be extracted off the line. Small deviations in cost often make visual fitting of the line difficult and may result in a learning curve that does not fit the data.

Greater accuracy may be achieved by mathematically calculating the least squares best fit line. This requires a log-linear transformation of the learning curve formula which produces the following formula:

$$\text{Log } Y = \text{Log } A + b * \text{Log } X \qquad (4)$$

With the log linear transformation, the logarithmic least squares line may be calculated by using the actual cost data to simultaneously solve the following normal equations:

$$\sum(\text{Log } Y * \text{Log } X) = \text{Log } A * \sum \text{Log } X + b \sum \text{Log } X^{**2} \qquad (5)$$

$$\sum \text{Log } Y = N \text{ Log } A + b \sum \text{Log } X \qquad (6)$$

(12:A-1)

There are many linear regression models and learning curve programs available to assist the analyst in solving for the least squares best fit equation. The fitting of a unit learning curve is a routine procedure since this formulation deals with unit costs.

Curve Fitting for Cumulative Average. The fitting of cumulative average data is complicated because the Y values are cumulative average costs and not unit costs. In "The Cumulative Average Learning Curve, A Small (?) Anomally," Jeff Daneman demonstrated two techniques used for the fitting of cumulative average data (8:1). Jeff Daneman shows that the two techniques may also provide different estimating equations and predictions of cost. This section will review the two specific techniques. The data provided

in Table III have been used to fit a cumulative average learning curve with the elementary technique (ET) and the Calot technique.

Table III

Sample Data Used to Fit the Learning Curves

Unit	Cum Average Cost	Unit Cost
1	1000	1000
2	910	820
3	843	710
4	788	620
5	750	600
6	717	550
7	689	520
8	666	510

(8:1)

Elementary Technique. The elementary technique (ET) employs the logarithmic transformation of Equation (2). Once transformed the equation becomes:

$$\text{Log } Y = \text{Log } A + b \text{ Log } X \tag{7}$$

ET then uses this equation to derive the least squares best fit line and provides an estimate for b and for Log A. These values can then be substituted into Equation (2) to provide an estimating equation for cumulative average costs. When the sample data were fitted with ET, the following cumulative average cost estimating equation was derived:

$$\bar{Y} = 1027 * X^{**}(-.1994) \tag{8}$$

where Y = the average cost of units 1 through X
1027 = estimated A value
X = cumulative production unit
$-.1994$ = estimated b value corresponding to a slope of 87.09%

For the prediction of unit cost, Equation (3) was employed with the estimated values for b and A, and the following unit cost estimating equation was derived:

$$Y = 1027 * X^{**}(.8006) - (X-1)^{**}(.8006) \qquad (9)$$

where Y = the unit cost for unit # X
.8006 = (b+1) or (-.1994 + 1)
all other variables are previously defined

The following table provides the predicted values for the cumulative average costs as derived from Equation (8) and the unit cost as derived from Equation (9).

Table IV

Cost Predictions Based on ET Fitting

Unit	Cum Average Cost	Unit Cost
1	1027	1027
2	894	762
3	825	687
4	779	641
5	745	610
6	718	585
7	697	566
8	678	550

Calot. Calot begins by directly estimating unit cost with Equation (3). Note: The public domain computer program, Calot, employs a weighted least squares technique, based on lot sample size. This thesis is not addressing the "weighted least squares" issue. Otherwise what is described herein is accurate. In order to make the logarithmic transformation, Calot determines a "lot plot point" with the equation:

$$LPP = \left[\frac{**(b+1 - (X-1)**(b+1)}{b+1}\right] **1/b \qquad (10)$$

where LPP = true lot mid point
all other variables are previously defined
(12:3)

By the mean value theorem of calculus, Equation (3) becomes:

$$Y = A * (b+1) * LPP**b \qquad (11)$$

where all variables are previously defined (12:3)

Calot can now begin fitting the data. Calot employs a logarithmic transformation of Equation (11), where LPP is initially set as X-1/2 when X>1 and LPP=1/3 when X=1. Calot then calculates a least squares best fit line and b. Using this computed b, Calot then derives a new set of LPPs, calculating another least squares best fit line and b. After two or three iterations, the computed b does not noticeably differ from that of the prior iteration, and this procedure halts (9:41). Once the A and b values have been estimated, they are substituted into Equation (11) to produce an estimating equation.

When the sample data were fitted with Calot, the following unit cost estimating equation was derived:

$$Y = 823 * LPP**(-.2235) \qquad (12)$$

where Y = the unit cost for unit # X
823 = A * (b+1), so A = 1060
LPP = the LPP for unit being estimated
-.2235 = estimated b value corresponding to a slope of 85.65%

The following table provides the predicted unit cost as derived from Equation (12).

Table V

Cost Predictions Based on Calot Fitting

Unit	LPP	Unit Cost
1	.32	1059
2	1.46	756
3	2.48	672
4	3.49	623
5	4.49	589
6	5.49	563
7	6.49	542
8	7.49	525

ET vs Calot. A comparison of the sample unit cost, ET predicted unit cost, and the Calot predicted unit cost are shown in the following table.

Table VI

Comparison of Unit Costs

Unit	ET Est Cost	Calot Est Cost	Sample Unit Cost
1	1027	1062	1000
2	762	756	820
3	686	672	710
4	641	622	620
5	609	588	600
6	585	562	550
7	566	542	520
8	550	525	510

As shown in Table VI, differences exist between the values predicted from the estimating equations fitted with ET and Calot. These differences are a direct result of the two different fitting techniques. While both are acceptable

techniques, a cost estimator should use the technique which replicates the actual cost with greater accuracy. In a comparison of the estimating errors in Table VII, it can be seen that Calot fits the actual costs better than the ET fitting technique.

Table VII

Comparison of the Estimating Errors

Unit	(ET Cost/Actual) -1	(Calot/Actual) -1
1	.027	.062
2	-.071	-.078
3	-.034	-.054
4	.034	.003
5	.015	-.020
6	.064	.022
7	.088	.042
8	.078	.029
Average Absolute %	.051	.039
Standard Error	.066	.052

Curve Fitting with Lot Data. The previous example demonstrated that the two fitting techniques provide different estimating equations and estimates when used to fit single unit lots. The majority of DOD's system acquisitions are comprised of multiunit lots. The two fitting techniques may also be used to fit multiunit lot cost. This section will compare the two fitting techniques using multiunit lot costs. The cost data provided in Table VIII are the actual recurring lot costs for the Sikorsky SH-3, a U.S. Navy helicopter (2:C-75).

Table VIII

Actual Lot Cost for the SH-3
(Costs in Thousands of $CY81)

Lot	First Unit	Last Unit	Total Est Cost
1	1	9	111,677
2	10	29	56,018
3	30	78	102,284
4	79	149	138,610
5	150	194	68,603
6	195	230	56,668
7	231	266	48,168
8	267	296	43,015
9	297	320	35,028
10	321	344	42,953

Elementary Technique. When the SH-3 cost data were fitted with ET, the following cumulative average estimating equation was derived from Equation (2):

$$\bar{Y} = 31{,}857.13 * X^{**}(-.482) \qquad (13)$$

where $\bar{Y}$ = the average cost of units 1 through X
31,857.13 = estimated A value

X = the last unit of the lot X
-.482 = b value corresponding to an estimated slope of 71.60%

Table IX provides a comparison of the actual cumulative average lot cost and the estimated cumulative average cost as calculated from Equation (13).

Table IX
Comparison of the Cumulative Average Cost
(Costs in Thousands of $CY81)

Lot	Cum Avg Cost	ET Est Cost	% Error
1	12,409	11,047	-.11
2	5,783	6,285	.09
3	3,461	3,901	.13
4	2,742	2,856	.04
5	2,460	2,515	.02
6	2,321	2,317	.00
7	2,188	2,160	-.01
8	2,112	2,051	-.03
9	2,063	1,976	-.04
10	2,044	1,908	-.07

For estimating lot cost, the A and b values from Equation (13) were used with Equation (3) to provide the following equation:

$$Y = 31,857.13 \quad [L^{**}(.518) - (F-1)^{**}(.518)] \qquad (14)$$

where Y = predicted total lot cost
31857.13 = estimated A value
L = the last unit of the lot being estimated
F = the first unit of the lot being estimated
.518 = (b+1) value corresponding to an estimated slope of 71.60%

A comparison of the actual total lot cost and the ET total lot cost, as calculated from Equation (14), is provided in Table X.

Table X

Comparison of the Lot Costs
(Costs in Thousands of $CY81)

Lot	Total Lot Cost	ET Est Lot Cost	% Error
1	111,677	99,427	-.11
2	56,018	82,849	.48
3	102,284	122,031	.19
4	138,610	121,210	-.13
5	68,603	62,335	-.09
6	56,668	44,970	-.21
7	48,168	41,686	-.13
8	43,015	32,699	-.24
9	35,028	25,023	-.29
10	42,953	24,134	-.44

Calot. When Calot is used with multiunit lots, an additional estimating equation is required. When estimating total lot cost, Equation (11) becomes

$$Y = [A * (b+1) * LPP^{**}b] * N \quad (15)$$

where N = number of units in lot being estimated
all other variables previously defined

(9:39)

When the SH-3 cost data were fitted with Calot, estimating Equation (15) was transformed to provide the following equation for estimating total lot cost:

$$Y = [20,789.27 * (.607) * LPP^{**}-.393] * N \quad (16)$$

where Y = predicted total lot cost
20,789.27 = estimated A value
.607 = (b+1) value corresponding to an estimated slope of 76.16%
LPP = Lot Plot Point for lot being estimated where F-1<LPP and LPP<L
-.39 = b value corresponding to an estimated slope of 76.16%
N = number of units in lot being estimated

A comparison of the actual lot cost and the Calot lot cost, as calculated from Equation (16), is provided in Table XI.

Table XI

Comparison of Lot Costs
(Costs in Thousands of $CY81)

Lot	LPP	Actual Cost	Calot Cost	% Error
1	2.49	111,677	79,353	-.29
2	17.67	56,018	81,638	.46
3	50.72	102,284	132,157	.29
4	110.83	138,610	140,843	.02
5	170.80	68,603	75,313	.10
6	211.64	56,668	55,382	-.02
7	247.69	48,168	52,062	.08
8	280.82	43,015	41,297	-.04
9	307.89	35,028	31,864	-.09
10	331.90	42,953	30,937	-.28

Once the lot costs have been calculated with Calot, the cumulative average cost may be calculated with the following equation:

$$\bar{Y}i = \sum Yi / \sum Ni \qquad (17)$$

where $\bar{Y}i$ = cumulative average cost through lot i
Yi = total lot cost for lot i
Ni = number of units in lot i
summation from 1 to i lots

Table XII provides a comparison of the actual cumulative average lot cost and the Calot cumulative average lot cost as calculated from Equation (17).

Table XII

Comparison of the Cumulative Average Cost
(Costs in Thousands of $CY81)

Lot	Total Cost	Calot Cost	% Error
1	12,409	8,817	-.29
2	5,783	5,551	-.04
3	3,461	3,758	.09
4	2,742	2,913	.06
5	2,460	2,625	.07
6	2,321	2,455	.06
7	2,188	2,319	.06
8	2,112	2,223	.05
9	2,063	2,156	.05
10	2,044	2,095	.03

ET vs Calot. The fitting of the SH-3 cost data has demonstrated that ET and Calot produce different estimating equations. These different estimating equations are a direct result of the two fitting techniques.

A comparison of the estimating errors, provided in Table III, indicates that the ET method fits the actual cumulative average cost better than the Calot method. This is to be expected since the ET method directly estimates the cumulative average cost and Calot indirectly estimates the cumulative average costs from the calculated lot costs.

Table XIII

Comparison of the Cumulative Average Estimating Errors

Lot	ET % Error	Calot % Error
1	-.11	-.29
2	.09	-.04
3	.13	.09
4	.04	.06
5	.02	.07
6	.00	.06
7	-.01	.06
8	-.03	.05
9	-.04	.05
10	-.07	.03
Average Absolute %	.054	.080
Standard Error	.067	.107

A comparison of the estimating errors for the predicted lot costs, provided in Table XIV, indicates that the Calot predicted lot costs fits the actual lot costs with greater accuracy than the ET predicted lot costs.

Table XIV

Comparison of Lot Cost Estimating Errors

Lot	ET % Error	Calot % Error
1	-.11	-.29
2	.48	.46
3	.19	.29
4	-.13	.02
5	-.09	.10
6	-.21	-.02
7	-.13	.08
8	-.24	-.04
9	-.29	-.09
10	-.44	-.28
Average Absolute %	.231	.167
Standard Error	.263	.220

Scope and Limitations

It has been demonstrated that the two techniques for fitting cumulative average learning curves, the elementary technique (ET) and Calot, can provide different estimating equations and predictions when used to fit cost data. This research will attempt to determine which technique is the most accurate when used to fit the actual recurring total lot cost from the acquisition of many various military systems.

Since the majority of weapon system acquisitions are comprised of multiunit lots, this research will only apply the two fitting techniques to multiunit lot cost data.

II. Methodology

Introduction

This chapter provides an overview of the methodology used to determine which fitting technique provides the greatest accuracy when used to fit a cumulative average learning curve with historical lot cost data. Included in the overview are sections on the historical cost data, the fitting of the data, and testing the results.

Historical Cost Data

The historical cost data used in this research are the annual total recurring cost of various military systems. Included in the data set are various system types including aircraft, armament, electronics, helicopters, jet engines, and missiles. The data set is comprised of the annual total recurring cost and lot quantities for 66 different systems. The data have been extracted from the Aircraft Cost Handbook (2) and a previous thesis by Hugh Bolton (5).

Only recurring production costs have been used for fitting the cumulative average learning curves. Total cost would include sunk, or nonrecurring, cost that would interfere with estimating learning curve characteristics. The cost data inputs also provide the annual quantity of units acquired. Individual system costs are inputted and fitted independently of the other systems. The input cost data for the SH-3 Helicopter were previously displayed in Table VIII. All systems have been inputted in the same format.

Learning curves are most applicable when used with decreasing recurring costs. It has been noted that programs often experience an increase in cost when a system is nearing the end of production. This has been attributed to many causes such as changing production rates, worker slowdown, transfer of experienced workers and managers to new jobs, tooling transfer, and possible inclusion of shut-down or nonrecurring costs (1:7-71 to 7-73). These increases in costs are often identified by a learning curve which exhibits an upward turn or "toe-up." Presently it is not possible to determine how much of the increasing costs are not true recurring costs. Since this thesis is fitting total lot cost to the cumulative average learning curve in an attempt to prove whether one fitting technique is more accurate than another, only lot costs that exhibit a decreasing trend will be used for the fitting of the learning curves. Lots that exhibit a significant increase in costs will not be used in the fitting of the cumulative average learning curves. It should be noted that this omission will only apply to lots that are near the end of a production cycle. The determination of which lots to omit will be based on an F-Test. The F-Test will help identify lots that exhibit increasing costs which are significantly different from previous lots. Those lots which produce a toe-up and create a learning curve which is not appropriate for estimating cost will be omitted from the system inputs.

A detailed explanation of the F-Test is provided later in the chapter.

Fitting the Data

This section provides a review of the computer program used to fit the historical cost data to the cumulative average learning curve. Subsections provide detailed explanations of the fitting program and the outputs.

Fitting Program. Fitting of the cost data was accomplished with a computer program written by Jeff Daneman. The program was developed specifically for this research. The program uses the Elementary Technique (ET) and Calot to fit cumulative average learning curves to inputted lot sizes and total lot cost. A portion of the Calot program was extracted from a learning curve program written by Larry Hutchinson (9). A listing of the basic program is provided in Appendix A. The program output provides a summary of the annual average costs, the cumulative average costs, the total lot costs, estimates of each of these costs using ET and Calot, an F-Test, the calculated values for A and b, and error measurements. A copy of the program output is provided in Table XV. Later in the chapter, Table XV has been subdivided into smaller tables to aid the explanations of the program output.

Table XV

SH-3 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	12,408.56	12,408.56	10,965.38	-0.12	8,501.90	-0.31
2.00	2,800.90	5,782.59	6,280.47	0.09	5,462.92	-0.06
3.00	2,087.43	3,461.27	3,920.40	0.13	3,761.65	0.09
4.00	1,952.25	2,742.21	2,880.37	0.05	2,947.62	0.07
5.00	1,524.51	2,459.75	2,540.14	0.03	2,668.71	0.08
6.00	1,574.11	2,321.13	2,342.33	0.01	2,503.01	0.08
7.00	1,338.00	2,188.08	2,185.58	-0.00	2,369.64	0.08
8.00	1,433.83	2,111.63	2,077.13	-0.02	2,276.19	0.08
9.00	1,459.50	2,062.72	2,001.41	-0.03	2,210.35	0.07
10.00	1,789.71	2,043.67	1,933.64	-0.05	2,150.98	0.05
11.00	1,805.13	2,033.71	1,894.73	-0.07	2,116.69	0.04
STANDARD ERROR				0.068		0.117

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	31,226.49	19,339.78
EXPONENT	-0.48	-0.38
SLOPE	71.88	77.05
R SQR	1.00	0.98
STD ERR EST	0.07	0.25

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	9.00	2.54	111,677.00	98,688.38	-0.12	76,517.07	-0.31
10.00	29.00	17.69	56,018.00	83,445.33	0.49	81,907.50	0.46
30.00	78.00	50.75	102,284.00	123,657.60	0.21	134,984.00	0.32
79.00	149.00	110.87	138,610.00	123,384.00	-0.11	145,786.50	0.05
150.00	194.00	170.81	68,603.00	63,611.99	-0.07	78,534.94	0.14
195.00	230.00	211.65	56,668.00	45,947.62	-0.19	57,961.56	0.02
231.00	266.00	247.70	48,168.00	42,630.65	-0.11	54,632.11	0.13
267.00	296.00	280.81	43,015.00	33,463.56	-0.22	43,427.83	0.01
297.00	320.00	307.89	35,028.00	25,622.33	-0.27	33,559.80	-0.04
321.00	344.00	331.90	42,953.00	24,722.20	-0.42	32,625.50	-0.24
345.00	359.00	351.46	27,077.00	15,035.34	-0.44	19,956.47	-0.26
STANDARD ERROR					0.280		0.231

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	4.49	3.26	
CURVE FIT WITH THE CALOT TECHNIQUE	3.63	3.26	

FIRST UNIT, LAST UNIT FOR PREDICT	360	380
PREDICTION WITH ELEMENTARY TECHNIQUE	20,555.94	
PREDICTION WITH CALOT TECHNIQUE	27,419.96	

Actual Lot Average Costs. The costs displayed in Table XVI are the lot average costs and the cumulative average costs that are determined from the inputted annual total lot costs.

The lot average costs are calculated by dividing the total lot cost by the number of units in the lot. An example of this is the lot average cost for lot 2 where 2800.90 = 56018.00 / 20. The actual lot average costs are provided under the column headed LOT AVG.

The cumulative average costs are calculated with Equation (16) where the inputs are the actual total lot costs and quantities. The actual cumulative average costs are provided under the column headed CUM AVG.

Table XVI

Actual Lot Average Costs and Cumulative Average Costs

LOT	LOT AVG	CUM AVG
1.00	12,408.56	12,408.56
2.00	2,800.90	5,782.59
3.00	2,087.43	3,461.27
4.00	1,952.25	2,742.21
5.00	1,524.51	2,459.75
6.00	1,574.11	2,321.13
7.00	1,338.00	2,188.08
8.00	1,433.83	2,111.63
9.00	1,459.50	2,062.72
10.00	1,789.71	2,043.67
11.00	1,805.13	2,033.71

Calculated Cumulative Average Cost. The cumulative average costs that have been calculated with the ET and Calot fitted learning curves are displayed in Table XVII.

The cumulative average costs that have been calculated with the ET fitted learning curve are displayed under the column headed ET CUM AVG. The ET CUM AVG costs have been calculated with Equation (2) using the ET fitted values for A and b. The percentage errors between the ET CUM AVG and the CUM AVG from Table XVI are provided under the column headed % error. A negative sign corresponds to an underestimate by that estimating technique.

The cumulative average costs that have been calculated with the Calot fitted learning curve are displayed under the column headed CALOT CUM AVG. The CALOT CUM AVG costs have been calculated with Equation (16) using the Calot estimated total lot costs as displayed in Table XX. The percentage errors between the CALOT CUM AVG and the CUM AVG from Table XVI are provided under the column headed % ERROR. The % Standard Errors are displayed and will be explained later in the chapter.

Table XVII

ET and Calot Calculated Cumulative Average Costs

ET CUM AVG	%ERROR	CALOT CUM AVG	%ERROR
10,965.38	-0.12	8,501.90	-0.31
6,280.47	0.09	5,462.92	-0.06
3,920.40	0.13	3,761.65	0.09
2,880.37	0.05	2,947.62	0.07
2,540.14	0.03	2,668.71	0.08
2,342.33	0.01	2,503.01	0.08
2,185.58	-0.00	2,369.64	0.08
2,077.13	-0.02	2,276.19	0.08
2,001.41	-0.03	2,210.35	0.07
1,933.64	-0.05	2,150.98	0.05
1,894.73	-0.07	2,116.69	0.04
Standard Error	0.068		0.117

Fitted Values for A and b. The program output displayed in Table XVIII provides the estimates for the first unit cost (A), the exponent (b), the learning curve slope, R square, and the standard error estimate. These estimates are provided for the ET and Calot fitted learning curves and are provided under their respective headings of FITTING WITH ET and FITTING WITH CALOT.

The ET and Calot fitting techniques are each used to fit the cumulative average learning curve to the annual program data. These fitting techniques provide estimated values for the first unit cost (A) and the exponent (b). The calculated first unit costs (A) are displayed to the right of the heading FIRST UNIT and the b values are displayed to the right of the heading EXPONENT. The value SLOPE is the calculated learning curve rate expressed as a percentage. The coefficient of determination (R SQR) and the standard error of the estimate (STD ERR EST) are provided for each of the learning curves as fitted with ET and Calot.

Table XVIII

ET and Calot Estimating Variables

FITTING WITH ET		FITTING WITH CALOT
FIRST UNIT	31,226.49	19,339.78
EXPONENT	-0.48	-0.38
SLOPE	71.88	77.05
R SQR	1.00	0.98
STD ERR EST	0.07	0.25

Inputted Total Lot Cost. The inputted lot cost and lot quantities are displayed in Table XIX along with the lot plot points which are calculated with the Calot technique as described in Chapter I. The lot sizes are calculated from the inputted FIRST UNIT and LAST UNIT for each lot. The corresponding inputted lot costs are displayed under the column headed LOT TOTAL.

The lot plot points, as derived by Calot and Equation (10), are displayed under the column headed LPP. These lot plot points are used in conjunction with Equation (15) to calculate the Calot estimated total lot costs.

Table XIX

Inputted Lot Sizes and Total Lot Cost

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL
1.00	9.00	2.54	111,677.00
10.00	29.00	17.69	56,018.00
30.00	78.00	50.75	102,284.00
79.00	149.00	110.87	138,610.00
150.00	194.00	170.81	68,603.00
195.00	230.00	211.65	56,668.00
231.00	266.00	247.70	48,168.00
267.00	296.00	280.81	43,015.00
297.00	320.00	307.89	35,028.00
321.00	344.00	331.90	42,953.00
345.00	359.00	351.46	27,077.00

Estimated Total Lot Cost. The ET and Calot estimated total lot costs are provided in the program output displayed in Table XX.

The ET estimated lot costs are displayed under the column headed ET EST. The ET EST costs have been estimated with Equation (3) using the ET calculated A and b values as

previously provided in Table XVIII. The percentage errors between the ET EST and the LOT TOTAL from Table XIX are provided under the column headed % ERR.

The Calot estimated total lot costs are displayed under the column headed CA EST. The CA EST costs have been estimated with Equation (15) using the Calot calculated A and b values from Table XVIII and the lot plot points (LPP) from Table XIX. The percentage errors between the CA EST and the LOT TOTAL from Table XIX are provided under the column headed % ERR.

Table XX

Lot Costs as Estimated with ET and Calot

ET EST	% ERR	CA EST	% ERR
98,688.38	-0.12	76,517.07	-0.31
83,445.33	0.49	81,907.50	0.46
123,657.60	0.21	134,984.00	0.32
123,384.00	-0.11	145,786.50	0.05
63,611.99	-0.07	78,534.94	0.14
45,947.62	-0.19	57,961.56	0.02
42,630.65	-0.11	54,632.11	0.13
33,463.56	-0.22	43,427.83	0.01
25,622.33	-0.27	33,559.80	-0.04
24,722.20	-0.42	32,625.50	-0.24
15,035.34	-0.44	19,956.47	-0.26
Standard Error	0.280		0.231

F-Test for Curve Fit. A portion of the program performs a statistical F-Test on the cumulative average learning curves that have been fitted with ET and Calot. The F-Test used in the fitting program is based on research performed by Jeff Daneman (7). Here, the F-Test provides information to determine if the cumulative average learning

curve is appropriate for estimating costs. The F-Test is performed independently on the ET and Calot fitted learning curves. The discussion of the F-Test applies equally to each of the fitted curves.

To perform the F-Test for each fitting technique, the program calculates the fitted learning curve using all of the inputted data. The program then divides the data set into two equal segments and calculates two additional learning curves, an upper and a lower. Once the three learning curves have been calculated, the F-Test determines if the b values for the individual learning curve are significantly different from the b values calculated for the upper and lower learning curves. In the event of a perfect fit, all three learning curves would have identical b values. If the three learning curves are approximately the same, then the single learning curve is appropriate for estimating costs. The measurement of the three learning curves is reflected with a calculated F-Value.

The fitting program calculates an F-Value for each of the fitted learning curves. This F-Value is identified as F-Calc. The program also provides the F-Table value for a 90% level of significance. The two F-Values are then compared to test the following hypotheses.

Null Hypothesis: If F-Calc $<$ F-Table
Then the fitted learning curve does not significantly differ from the upper and lower fitted learning curves.

Alternate Hypothesis: If F-Calc > F-Table (90%)
Then the fitted learning curve is not appropriate for estimating costs.

The F-Tests for the ET and Calot fitted learning curves are performed by the program. The F-Calc and F-Table for each of the fitted learning curves are provided in the output as displayed in Table XXI.

Table XXI

F-Test for ET and Calot Learning Curves

CURVE FIT WITH ELEMENTARY TECHNIQUE	F-CALC 4.49	F-TABLE 3.26	(90%)
CURVE FIT WITH THE CALOT TECHNIQUE	F-CALC 3.63	F-TABLE 3.26	(90%)

Based on the F-Test shown for the SH-3, neither the ET fitted cumulative average learning curve nor the Calot fitted cumulative average learning curve is appropriate for estimating costs. This is most likely attributable to a toe-up in the learning curve created by the increasing lot average costs for lots 10 and 11. When the SH-3 system is fitted again using only lots 1 through 10, with lot 11 removed, both the ET and the Calot fitted learning curves passed the F-Test, indicating that the fitted cumulative average learning curve, for both ET and Calot, is appropriate for estimating costs.

As stated in Chapter I, the research objective of this study is to determine whether ET or Calot better estimates cumulative average lot data. If the F-Test indicates that

neither the ET nor the Calot fitted curve is appropriate for the sample lot data, then it makes little sense to evaluate which technique better fits that sample. Such a situation is illustrated in Table XXI. Accordingly, the last year of lot data is deleted, and the F-Test is recomputed, as in the example. The procedure is repeated, deleting the last lot, until the null hypothesis is accepted. (Note: With four or fewer lots, the null hypothesis will be accepted, due to the nature of this F-Test. Once these lots have been deleted, the fitting program is rerun to see if the system still passes the F-Test. When the SH-3 system was fitted using lots 1 through 9, it again passed the F-Test.

For the purpose of this research, the largest number of lots of program data which pass the F-Test will be referred to as the total system and their associated program outputs are provided in Appendix B. The total system with the last lot extracted will be referred to as system minus last lot. Both the total system and the system minus last lot must pass the F-Test. The program runs for the system minus last lot are provided in Appendix B and will be used for testing the prediction capabilities of ET and Calot.

Last Lot Predictions. The fitting program will provide cost estimates for additional inputted lost sizes. This procedure provides the estimated total lot costs as calculated by the ET and Calot fitted learning curves. This output section is displayed in Table XXII.

Table XXII

Prediction of Last Lot Costs with ET and Calot

FIRST UNIT, LAST UNIT FOR PREDICT	360	380
PREDICTION WITH ELEMENTARY TECHNIQUE	20,555.94	
PREDICTION WITH CALOT TECHNIQUE	27,419.96	

The program provides these estimates based on the lot size indicated by the input of the first unit of the lot and the last unit of the lot. These predictions are made directly from the two fitted curves using equations similar to Equation (14) and Equation (15). This portion of the program will be used to predict the cost for the last lot that is excluded from the fitting of the total system minus the last lot.

Testing the Fitted Costs.

This section provides an overview of the methods used to determine which, if either, of the fitting techniques is more accurate. For the purpose of this research, the fitting techniques will be tested on their abilities to fit the actual costs and to predict additional lot costs. Subsections provide detailed explanations of the tests. All the two-tailed statistic tests will be performed at a 95% level of significance and all one-tailed statistic tests will be performed at a 97.5% level of significance.

Standard Error. The standard error is one of the key measurements that will be used for testing the accuracy of the two fitting techniques. The standard error provides a

measure of the differences between the actual costs and the costs estimated by both the ET and Calot fitted learning curves. The standard error is calculated by the fitting program for the cumulative average costs and the estimated total lot costs. The standard errors are provided in the output sections displayed in Table XVII and Table XX.

A standard error is computed as follows. Percentage errors (as in Table XX) are first computed. The standard error is the square root of the sum of the percentage errors squared, divided by N-1. Presented as an equation, standard error = SQRT ($\sum$(percentage error**2) / (N-1)). The result is a "representative percentage error." For example, in Table XX, the ET standard error is .28. Ignoring the ET % err minus signs, 8 of 11 lots had errors less than .28. The remaining lots had large percentage errors (42-49%). So, .28 appears to be a representative percentage error. In the same table, the Calot standard error is .231. Six of eleven lots had smaller percentage errors, and the remaining 5 lots had errors from 24%-46%. Again, the standard error is a reasonable representative percentage error. It can be shown that such a computation generally computes a representative percentage error.

The use of the standard error provides a consistent measurement of the differences between the actual and the estimated costs. Since it is a relative measure, it negates the need to convert the costs to the same constant year dollars. The use of the standard error further provides the

ability to compare systems even though they may differ significantly in total costs. This is an important aspect since the systems used in this research cover a magnitude of costs ranging from $14,000.00 to a high of $112,000,000.00.

Testing the Cumulative Average Costs. As stated in Chapter I, the ET technique should be expected to more accurately estimate the cumulative average costs since it fits these costs directly. To the contrary, Calot indirectly estimates the cumulative average costs once it has estimated the total lot costs.

The fitting of the cumulative average costs is not the intent of this research. It has been provided as a point of reference to demonstrate that while one technique may be more accurate when fitting the cumulative average costs, it may or may not be indicative that the ET technique more accurately estimates the total lot costs.

The presumption that the ET technique more accurately fits the cumulative average cost can be tested with a comparison of the standard errors of all 66 systems. The standard errors that are produced by the ET technique and the Calot technique will be compared to determine the number of wins for ET, given that ET scores a win if it produces the smaller standard error. The number of wins by ET will be tested with a binomial test to determine if the frequency of occurrence is significant.

If the ET technique and the Calot technique predict equally well, then each technique should be more accurate

(i.e., have a lower standard error) about 50% of the time. If ET is more accurate, then it should produce the smaller standard error more than 50% of the time. The frequency of occurrence may be tested by performing an upper limit test based on the following hypotheses.

Null Hypothesis: If ET's # of wins $\leq$ Upper Limit
Then the frequency of ET's wins is not significantly more than the frequency of Calot's wins and ET is no more accurate than Calot at estimating cum avg costs

Alternate Hypothesis: If ET's # of wins $>$ Upper Limit
Then the frequency of ET's wins is significant and ET is more accurate than Calot at estimating cum avg lots

Since the hypothesis testing is based on an inequality, the test will be a one-tailed test, using the 95% level of significance. For sample sizes greater than 20, the following equation may be used to determine the upper limit:

$$\text{Upper Limit} = NP + W\sqrt{NP(1-P)} \qquad (18)$$

where Upper Limit = critical region test statistic
N = sample size of the population
P = probability being tested, here P = .50
W = normal distribution Z-Value for significance level being tested, here W = 1.96

(6:98)

In the event that the Null Hypothesis is rejected, it would be assumed that ET is more accurate than Calot for estimating cumulative average cost. However, if the Null Hypothesis is accepted, it would then be possible for Calot to be more accurate than ET. Therefore, if the Null

Hypothesis is rejected, it would become necessary to perform the same test for Calot. This would be done by comparing the number of Calot wins to the upper limit, which would not change. The Null Hypothesis would only be changed to reflect that Calot is the technique being tested.

Testing Fitted Lot Costs. The determination of which fitting technique provides the greater accuracy when estimating total lot costs is a significant part of this research effort. Therefore, in addition to the binomial test, additional tests will be performed to help determine which fitting technique, ET or Calot, more accurately estimates total lot costs. The following tests will be based on the program runs consisting of the total systems as provided in Appendix B.

Binomial Test for Frequency. The fitted lot costs will be tested to determine if one of the fitting techniques, either ET or Calot, is more accurate significantly more often than the other. The binomial test will be applied in the same manner as previously described for the cumulative average costs. The number of wins for the technique being tested (i.e., how many times the technique provides the smaller standard error), will be compared to the upper limit calculated with Equation (18). The test will be a one-tailed test with a 95% level of significance. The following hypotheses will be tested.

Null Hypothesis: If the # of wins $\leq$ Upper Limit
Then the technique (Calot or ET) being tested is not more accurate significantly more often than the other technique (Calot or ET) for estimating total lot cost

Alternate Hypothesis: If the # of wins $>$ Upper Limit
Then the technique (Calot or ET) being tested is more accurate significantly more often than the other technique (Calot or ET) for estimating total lot cost

If Calot is the first technique tested and the null hypothesis is rejected, then it can be concluded that Calot is more accurate significantly more often than ET. In the event that the null hypothesis is accepted, it will be necessary to test the ET technique in the same manner.

T-Test for Significance. A T-Test will be used to determine if the differences between the ET Standard Errors and the Calot Standard Errors are significant, on the average (11:605). It is conceivable that one technique may have a smaller standard error more frequently, without the standard errors being significantly smaller. This latter concern is the function of the T-Test. The difference between the ET Standard Error and the Calot Standard Error is the system delta. The average of all the system deltas is the total population delta (Pop D). These measurements will be used to test the following hypotheses.

Null Hypothesis: If Pop D $\leq$ 0
The Calot is not significantly more accurate

Alternate Hypothesis: If Pop D >0
Then Calot is significantly more accurate

The T-Table value will be based on a one-tail test with a 97.5% level of significance and will be extracted from the table for the Student's T Distribution (11) with N-1 degrees of freedom, where N = number of systems in the population. The T-Table value will be compared to the T-Calc as calculated by the following equation:

$$\text{T-Calc} = \text{Pop D} / (S / \sqrt{N}) \quad (19)$$

where T-Calc = the test statistic
Pop D = the population mean
S = standard deviation of the population
N = number of systems in the population

(11:605)

If T-Calc is smaller than T-Table, accept the null hypothesis. Otherwise, conclude the alternate hypothesis. In the event that the null hypothesis is accepted, it would be necessary to perform the same test to determine if the ET technique is significantly more accurate.

Testing Last Lot Predictions. The testing described in this section will be used to determine which of the fitted learning curves, ET or Calot, provides the most accuracy when predicting an additional lot. These tests will be based on the data provided by fitting the total system minus last lot. The fitted curves are then used to predict the costs for the last lot. The detailed outputs for these runs are provided in Appendix C.

Binomial Test for Frequency. This test is similar to the two previous binomial tests. The test will determine if either the ET or Calot fitted learning curves predicts the last lot cost with more accuracy over 50% of the time. As with the previous tests, Equation (18) will be used to provide an upper limit. However, when the computer program is used to predict the last lot, the program does not yet contain the actual last lot cost. Since the program cannot compare the predicted cost to the actual cost, no standard error is calculated for the last lot prediction. Therefore, to determine a win, each of the predictions will be compared to the actual costs. A win will be scored for Calot if it provides the smaller absolute percentage difference, and likewise, a win will be scored for ET if it provides the smaller absolute percentage difference. The binomial test will be used to test the following hypotheses.

Null Hypothesis: If the # of wins $\leq$ Upper Limit Then the technique (Calot or ET) being tested is not more accurate significantly more often than the other technique (Calot or ET) for predicting the last lot

Alternate Hypothesis: If the # of wins $>$ Upper Limit Then the technique (Calot or ET) being tested is more accurate significantly more often than the other technique (Calot or ET) for predicting the last lot

If Calct is the first technique tested and the null hypothesis is accepted, then it will be necessary to test

the ET technique to determine if ET is more accurate significantly more often for predicting the last lot.

T-Test for Significance. ET and Calot will be individually tested to determine if either technique provides predictions which are significantly different from the actuals. The T-Tests will be based on a ratio comparison of the predicted costs and the actual costs. Each technique will be tested independently. The same methodology will be used to test each of the techniques.

For testing the predictive ability of the fitting techniques, it is important to determine if either of the techniques tends to significantly under- or overestimate the predicted lot costs. For this purpose, the following hypotheses will be tested.

Null Hypothesis: If Ratio Average = 1
Then the technique being tested does not significantly over- or underestimate cost predictions

Alternate Hypothesis: If Ratio Average $\neq$ 1
Then the technique being tested significantly over- or underestimates cost predictions

The T-Test will be based on a two-tailed test. T-Table will be extracted from the table of Student's T Distribution, N-1 degrees of freedom. The T-Calc will be based upon the ratio of the fitted predictions to the actual costs. This ratio will represent the prediction delta and will be calculated for each of the systems. The average of

the prediction deltas will provide the population delta (Pop D). The T-Calc will be calculated with the following equation:

$$\text{T-Calc} = (\text{Pop D} / (S / \sqrt{N}) \quad (20)$$

where T-Calc = the test statistic
Pop D = population mean for predictions
S = the standard deviation
N = the population size

Methodology Summary

The tests provided in the chapter should provide sufficient information to determine whether or not the two fitting techniques, ET and Calot, are significantly different. The tests should further provide indicators which will help to determine which technique is the more accurate.

III. Analysis

Introduction

The previous chapter provided an overview of the tests to be used to determine which fitting technique, ET or Calot, provides greater accuracy when used to fit historical lot cost data to the cumulative average learning curve model. This chapter will present the results of each of the tests as applied to the estimates provided by the ET and Calot fitted learning curves. More specifically, the test results are provided for the fittings of the cumulative average costs, the total lot cost, and last lot predictions.

Test Results

The test results for each of the three areas tested are provided in detail in the following subsections. Also provided are tables which summarize the standard errors and last lot predictions for each of the cumulative average learning curves as fitted by the ET and Calot fitting techniques.

Cumulative Average Costs. As previously indicated, the ET technique was expected to fit the cumulative average costs more accurately than the Calot technique. The one-tailed binomial test was performed at a 97.5% level of significance. The calculations for the test upper limit, as derived from Equation (18), are provided as follows:

$$40.96 = (66 * .50) + 1.96 * \sqrt{66(.50)(.50)} \qquad (21)$$

where 40.96 = upper limit test statistic
66 = sample size of the populations
.50 = probability for a binomial distribution
1.96 = Z-value for significance level of 97.5%, one-tailed

A summary of the ET and Calot standard errors for the fitting of the cumulative average costs has not been provided. However, upon review of the total system computer runs presented in Appendix B, it was noted that ET consistently scored a win for all 66 programs when fitting the cumulative average costs. In comparing the ET # of wins to the upper limit, the null hypothesis is rejected. Therefore, it is concluded that the frequency of wins for ET is significant and that ET is consistently more accurate than Calot for estimating cumulative average costs. Since the null hypothesis was not accepted, it is not necessary to test the Calot technique since only one technique can be more accurate more frequently than 50% of the time.

Fitted Lot Costs. The results of the binomial test for frequency and the T-Test for significance are provided in the following subsections.

Binomial Test for Frequency. A review of the system lot fitting errors provided in Table XXIII indicates that Calot exhibits the smaller absolute standard error for 51 of the 66 systems. The upper limit for the binomial test is the same as previously calculated in Equation (21). Upon comparing the # of wins for Calot, 51, to the upper limit of

40.96, the null hypothesis is rejected and it can be concluded that Calot is more accurate significantly more often (i.e., greater than 50% of the time) than ET for estimating total lot costs. As with the previous binomial test, since the null hypothesis was not accepted, it is not necessary to test the ET technique. It is noted that if this binomial test for frequency were performed at the 99% level of significance (one-tailed), the upper limit is 42.4. So, the same conclusion can be made with greater confidence than the predefined methodology indicates.

T-Test for Significance. The ET and Calot standard errors for fitting the system lot costs have been extracted from the computer runs in Appendix B and are displayed in Table XXIII. The system deltas have been calculated and displayed under ET-Calot in Table XXIII. These system deltas are used to determine the T-Calc for the hypothesis testing. The T-Calc test statistic is calculated with Equation (19) and presented as follows:

$$4.736 = .00815 \; / \; (.01398 / \sqrt{66}) \qquad (22)$$

where 4.736 = T-Calc test statistic
.00815 = the population mean, .538/66
.01398 = standard deviation of the population
66 = number of systems in the population

Table XXIII

System Lot Fitting Errors

Weapon System Designator	ET Standard Error	Calot Standard Error	ET-Calot
A-3D	.153	.138	.015
A-4	.262	.189	.073
A-5	.148	.153	-.005
A-6	.044	.044	.000
A-7A	.130	.128	.092
A-10A	.036	.036	.000
AH-1G	.050	.034	.016
AIM-7F (GD)	.132	.124	.008
AIM-7F (RAY)	.068	.065	.003
ARC-54	.036	.035	.001
ARC-109V	.083	.084	-.001
ASN-108	.068	.067	.001
ASQ-133	.082	.081	.001
ASW-32	.158	.161	-.003
B-52	.153	.151	.002
B-58	.115	.086	.029
C-5A	.061	.062	-.001
C-47	.161	.164	-.003
C-133	.104	.101	.003
CH-46	.031	.029	.002
EA-6B	.046	.041	.005
E-2C	.064	.061	.003
F-3D	.081	.078	.003
F-4	.154	.139	.015
F-5	.086	.086	.000
F-6	.084	.085	-.001
F-14	.056	.052	.004
F-15A/B	.028	.027	.001
F-16A/B	.157	.122	.035
F-84	.120	.122	-.002
F-89	.175	.140	.035
F-100AIR	.099	.086	.013
F-100ENG	.013	.012	.001
F-101	.128	.125	.003
F-102	.262	.240	.022
F-105	.177	.173	.004
F-106	.169	.163	.006
F-111	.051	.034	.017
F-404	.065	.058	.007
GBU-15	.072	.072	.000
H-34	.264	.242	.022
H-37	.128	.125	.003
H-53	.048	.048	.000
HH-52	.053	.046	.007
HH-54	.111	.104	.007
J-33	.162	.136	.026

Table XXIII (Continued)

System Lot Fitting Errors

Weapon System Designator	ET Standard Error	Calot Standard Error	ET-Calot
J-35	.135	.094	.041
J-57	.057	.048	.009
J-60	.024	.022	.002
J-69	.096	.090	.006
J-71	.216	.232	-.016
J-75	.035	.032	.003
J-79	.158	.133	.025
J-85	.051	.041	.010
OH-58	.022	.021	.001
P-3C	.136	.127	.009
S-3A	.038	.034	.004
SH-3	.263	.220	.043
T-38	.131	.131	.000
T-39	.258	.273	-.015
TF-30	.043	.036	.007
TF-33	.032	.030	.002
TF-34	.041	.035	.006
TF-39	.044	.033	.011
UH-1N	.047	.039	.008
UH-60	.097	.094	.003
	Average		.538
	Standard Deviation		.01398

The T-Table value for a one-tailed test with a 97.5% level of significance is 2. Since T-Calc of 4.736 is greater than T-Table 2.0, the null hypothesis is rejected and it is concluded that Calot is significantly more accurate for estimating total lot costs. As with the binomial test for frequency, it is not necessary to test ET since the null hypothesis was not accepted. Again note that this T-Calc also exceeds the T-Table value of 2.38 for a one-tailed test with 99% level of significance.

Last Lot Predictions. The test results for predicting the last lot costs, for both the ET technique and the Calot technique, are provided in the following subsections. The last lot predictions were tested for frequency of occurrence and significance.

The ET and Calot predicted last lot costs have been calculated for all 66 systems. The computer runs for these costs have been included in Appendix C. The predicted last lot costs, the actual last lot costs, and comparisons of these costs have been accumulated and are presented in Tables XXIV and XXV.

Binomial Test for Frequency. A review of Table XXIV and Table XXV indicates that Calot provides the smaller absolute percentage difference for predicting the last lot in 48 of 66 cases. This provides the test statistic of 48 wins for Calot. Upon comparing the Calot wins, 48, to the previously calculated upper limit, 40.96, the null hypothesis is rejected and it can be concluded that Calot is more accurate significantly more often than ET for predicting last lot costs. Since the null hypothesis was not accepted, it is not necessary to test the ET technique. It is noted as previously that the Calot wins also exceeds the 99% one-tailed upper limit.

T-Test for Significance. The ratios of the ET predictions to the actual costs have been provided in Table XXIV under the heading (ET/Calot)-1.

Table XXIV

Comparison of the ET Predicted Lot Costs to Actual Costs

Weapon System Designator	ET Lot Prediction	Actual Lot Cost	(ET/Actual)-1
A-3D	529.44	405.00	.307
A-4	224.00	119.00	.882
A-5	220.64	214.20	.030
A-6	246.78	255.00	-.032
A-7A	243.06	370.90	-.345
A-10A	152.33	156.30	-.025
AH-1G	18.06	19.77	-.086
AIM-7F (GD)	100.57	117.90	-.147
AIM-7F (RAY)	104.94	108.68	-.034
ARC-54	34912.50	37895.00	-.079
ARC-109V	5898.47	7073.80	-.166
ASN-108	859.16	942.00	-.088
ASQ-133	2849.03	2565.00	.111
ASW-32	573.23	721.00	-.205
B-52	2452.36	3112.20	-.212
B-58	554.23	431.00	.286
C-5A	1027.06	1070.80	-.040
C-47	97.99	155.84	-.371
C-133	217.60	219.50	-.009
CH-46	189.74	205.62	-.077
EA-6B	44.66	43.20	.034
E-2C	49.63	58.00	-.144
F-3D	218.70	251.30	-.130
F-4	925.03	616.90	.499
F-5	259.75	285.10	-.089
F-6	357.08	363.60	-.018
F-14	389.83	428.20	-.090
F-15A/B	1714.77	1849.61	-.073
F-16A/B	758.32	615.60	.232
F-84	85.55	105.70	-.191
F-89	535.44	435.80	.229
F-100AIR	529.00	665.00	-.205
F-100ENG	824.08	794.20	.038
F-101	1015.45	1186.56	-.144
F-102	253.07	309.40	-.182
F-105	360.38	448.40	-.196
F-106	973.24	1252.35	-.223
F-111	1152.47	1031.00	.118
F-404	116.30	97.20	.197
GBU-15	4337.66	4186.00	.036
H-34	55310.13	106546.00	-.481
H-37	48409.95	42570.00	.137
H-53	100.83	110.55	-.088
HH-52	9458.92	10656.00	-.112
HH-54	57.83	78.25	-.261
J-33	192.65	251.20	-.233

Table XXIV (Continued)

Comparisons of the ET Predicted Lot Costs to Actual Costs

Weapon System Designator	ET Lot Prediction	Actual Lot Cost	(ET/Actual)-1
J-35	218.81	171.00	.280
J-57	2029.52	1754.80	.157
J-60	10.30	10.40	-.010
J-69	15.95	20.10	-.206
J-71	134.38	265.30	-.493
J-75	156.26	166.90	-.064
J-79	669.67	454.40	.474
J-85	171.70	152.60	.119
OH-58	14508.73	14372.00	.010
P-3C	79.02	66.40	.190
S-3A	252.26	278.70	-.095
SH-3	23531.39	42953.00	-.452
T-38	146.71	164.50	-.108
T-39	49.11	65.40	-.249
TF-30	1042.81	938.30	.111
TF-33	226.90	237.50	-.045
TF-34	92.48	97.60	-.052
TF-39	163.26	148.50	.099
UH-1N	19428.68	20419.00	-.048
UH-60	169074.50	226038.00	-.252

These ratios are used with Equation (20) to determine the T-Calc for the hypothesis testing. The ET T-Calc test statistic is calculated as follows:

$$-1.216 = 1.03445 \,/\, (.23023/\sqrt{66}) \qquad (23)$$

where 1.216 = T-Calc test statistic for ET
-.03445 = the population mean
.23023 = standard deviation of the population
66 = number of systems in the population

The T-Table value for a two-tailed test with a 90% level of significance is $\pm$1.671. Since $-1.671 < \text{T-Calc} < 1.671$, the null hypothesis is accepted. Therefore, it is concluded that the ET technique does not significantly over- or under-estimate new lot cost predictions, on the average.

The ratios of Calot predictions to the actual costs have been provided in Table XXV under the heading (Calot/Actual)-1. These ratios have been used with Equation (20) to determine the T-Calc for the hypothesis testing. The T-Calc test statistic for Calot is calculated as follows:

$$-1.218 = -.02644 \;/\; (.17630/\sqrt{66}) \qquad (24)$$

where -1.218 = T-Calc test statistic for Calot
-.02644 = the population mean
.17638 = standard deviation of the population
66 = number of systems in the population

The T-Table value is the same as the one previously used for ET's T-Test. Since-1.671 T-Calc 1.671, the null hypothesis is accepted. Therefore, it is concluded that the Calot technique does not significantly over- or underestimate new lot cost predictions, on the average.

Table XXV

Comparison of the Calot Predicted Lot Costs to Actual Costs

Weapon System Designator	Calot Prediction	Actual Cost	(Calot/Actual)-1
A-3D	468.73	405.00	.157
A-4	162.66	119.00	.367
A-5	269.55	214.20	.258
A-6	243.51	255.00	-.045
A-7A	246.84	370.90	-.334
A-10A	147.35	156.30	-.057
AH-1G	18.77	19.77	-.051
AIM-7F (GD)	113.24	117.90	-.040
AIM-7F (RAY)	109.90	108.68	.011
ARC-54	34713.29	37895.00	-.084
ARC-109V	5720.76	7073.80	-.191
ASN-108	882.63	942.00	-.063
ASQ-133	2828.61	2565.00	.103
ASW-32	518.23	721.00	-.281
B-52	2680.06	3112.20	-.139
B-58	522.87	431.00	.213
C-5A	1013.57	1070.80	-.053
C-47	99.88	155.84	-.359
C-133	252.25	219.50	.149
CH-46	189.33	205.62	-.079
EA-6B	43.64	43.20	.010
E-2C	49.25	58.00	-.151
F-3D	236.95	251.30	-.057
F-4	810.97	616.90	.315
F-5	256.38	285.10	-.101
F-6	357.72	363.60	-.016
F-14	403.32	428.20	-.058
F-15A/B	1710.55	1849.61	-.075
F-16A/B	687.16	615.60	.116
F-84	79.83	105.70	-.245
F-89	481.04	435.80	.104
F-100AIR	557.69	665.00	-.161
F-100ENG	821.15	794.20	.034
F-101	1039.02	1186.56	-.124
F-102	259.06	309.40	-.163
F-105	405.04	448.40	-.097
F-106	1243.22	1252.35	-.007
F-111	1117.64	1031.00	.084
F-404	114.63	97.20	.179
GBU-15	4484.17	4186.00	.071
H-34	69045.04	106546.00	-.352
H-37	48247.77	42570.00	.133
H-53	98.37	110.55	-.110
HH-52	9720.55	10656.00	-.088
HH-54	58.16	78.25	-.257
J-33	247.40	251.20	-.015

Table XXV (Continued)

Comparison of the Calot Predicted Lot Costs to Actual Costs

Weapon System Designator	Calot Prediction	Actual Lot Cost	(Calot/Actual)
J-35	196.61	171.00	.150
J-57	1984.44	1754.80	.131
J-60	10.48	10.40	.008
J-69	16.39	20.10	-.185
J-71	134.61	265.30	-.493
J-75	157.96	166.90	-.054
J-79	640.95	454.40	.411
J-85	169.71	152.60	.112
OH-68	14337.30	14372.00	-.002
P-3C	82.74	66.40	.246
S-3A	253.45	278.70	-.091
SH-3	28997.99	42953.00	-.324
T-38	147.74	164.50	-.102
T-39	72.23	65.40	.104
TF-30	1035.74	938.30	.104
TF-33	224.48	237.50	-.055
TF-34	96.99	97.60	-.006
TF-39	162.54	148.50	.094
UH-1N	20400.09	20419.00	-.001
UH-60	171199.80	226038.00	-.243

IV. Conclusions and Recommendations

Conclusions

The ET and Calot fitting techniques were reviewed and tested in an attempt to determine which technique provides the greater accuracy when used to fit nistorical lot costs to the cumulative average learning curve. The test results from Chapter III have oeen reviewed and a summary of the findings are presented in Table XXVI.

Table XXVI

Summary of Test Results

Hypothesis Tested	Calot Passes	ET Passes
Provides significant % of wins for estimating cumulative average costs		X
Provides significant % of wins for estimating total lot costs	X	
Provides significantly lower standard error in estimating total lot	X	
Provides significant % of wins for estimating last lot costs	X	
Estimates for last lot costs do not significantly differ from actual costs	X	X

Table XXVI clearly indicates that Calot is more accurate than ET when estimating lot costs. The test

results further indicate that Calot is more accurate more frequently than 50% of the time for estimating lot costs and lot predictions. While both techniques, ET and Calot, do not significantly over- or underestimate the last lot costs, it is noted that Calot provides the lower standard error more frequently. This research study therefore concludes that the Calot technique takes historical cost data and fits the cumulative average learning curve model more accurately to individual lot costs than does the ET technique. Since the accuracy of the fitting technique determines the estimating capability of the cumulative average learning curve, Calot should provide greater accuracy for estimating costs.

Recommendations for Future Research

A review of the test results in Chapter III indicates that both ET and Calot frequently underestimate the costs for the last lots. While the underestimation does not seem to be significant, it further suggests that a toe up is frequently occurring. The accuracy of learning curves could be enhanced with further research of this occurrence.

In addition, the issue of using weighted least squares was not addressed in this research effort. Further research to determine if the use of weighted least squares would increase the accuracy of the Calot fitting technique is another area for future research.

Finally, the F-Test as described in Chapter III was used frequently on the system data sets in Chapter III to cut back the program size until the cumulative average model was appropriate for the data with both fitting techniques. Perhaps a larger program size would have been fit using the unit learning curve model. A further area of research, then, would be to determine if the unit or cumulative average model is generally more appropriate for estimating annual lot cost data.

Appendix A: Computer Program for Testing ET and Calot

Appendix A provides a complete printout of the computer program which was used for fitting the historical lot costs. It fits the historical data with the ET and Calot fitting techniques. This program was used to generate the computer outputs provided in Appendix B and Appendix C.

```
05 REM "CUMAV" PROGRAM FOR FITTING COSTS WITH THE
10 REM ELEMENTARY AND CALOT FITTING TECHNIQUES
20 DIM X[25],Y[25],T$[8],O[8,3],F[25],L[25],T[25]
30 DIM CU[25],AY[25],LPP[25],CY[25],YTCA[25],YTPP[25]
40 DIM ECA[25],EPP[25],U[25],V[25],FCALC[2],ET[25],CA[25]
41 DIM PERET[25],PERCA[25]
50 ERC%=DEFLPRINT("[SPL]")
60 DATA "FIRST UNIT","EXPONENT","SLOPE","R^2"
70 DATA "STD ERR EST","  PREDICT","SLOPE ERR"
80 FOR I=1 TO 7
90 READ T$[I]
100 NEXT I
110 INPUT "  WHAT IS YOUR NAME";N$
114 LPRINT
115 LPRINT
116 LPRINT
117 LPRINT
120 LPRINT N$  ;"  'S CUMULATIVE AVERAGE LEARN CURVE RUN"
130 LPRINT
140 INPUT "  HOW MANY LOTS          ";N
150 INPUT "  IS DATA FROM THE TERMINAL (T) OR A FILE (F)
";D$
160 IF D$ = "F" GOTO 170 ELSE 230
170 INPUT "  DATA SET NAME  ";N$
180 OPEN "I",1,N$
190 FOR I = 1 TO N
200 INPUT# 1,F[I],L[I],T[I]
210 NEXT I
220 GOTO 280
230 PRINT "  FOR EACH OBSERVATION,TYPE:FIRST UNIT,LAST"
240 PRINT "  UNIT,TOTAL COST  -THEN RETURN"
250 FOR I=1 TO N
260 INPUT F[I],L[I],T[I]
270 NEXT I
280 F1$="\           \"
290 F2$="#######,.##"
300 F3$= "####.###"
310 F4$="\        \"
320 F5$="\              \"
330 F6$="##########,.##"
332 F7$="\      \"
333 F8$= "#######.###"
335 F9$="\                                    \"
336 F10$= "######.###"
340 S1=L[1]-F[1]+1
350 CU[1]=S1
360 AY[1]=T[1]/S1
370 CY[1]=AY[1]
380 TY=T[1]
390 IF F[1] = 1 GOTO 400 ELSE 420
400 LPP[1] = LOG( L[1] ) - 1
```

```
410 GOTO 450
420 LPP[1] = L[1] *( LOG( L[1] ) - 1 )
430 LPP[1]= LPP[1] - ( F[1]-1 )* ( LOG(F[1]-1) - 1 )
440 LPP[1]= LPP[1] / ( L[1] -F[1] + 1 )
450 FOR I=2 TO N
460 S=L[I]-F[I]+1
470 CU[I]=CU[I-1]+S
480 LPP[I] = L[I] *( LOG( L[I] ) - 1 )
490 LPP[I]= LPP[I] - ( F[I]-1 )* ( LOG(F[I]-1) - 1 )
500 LPP[I]= LPP[I] / ( L[I] -F[I] + 1 )
510 AY[I]=T[I]/S
520 TY=TY+T[I]
530 CY[I]=TY/CU[I]
540 NEXT I
550 FOR I=1 TO N
560 X[I]=LOG(CU[I])
570 Y[I]=LOG(CY[I])
580 NEXT I
590 J=1
600 GOSUB 2950
610 B=O[2,1] + 1
620 FOR I= 1 TO N
630 YTCA[I] = L[I]^B
640 YTCA[I]= YTCA[I]-(F[I] - 1 )^B
650 YTCA[I]= O[1,1] * YTCA[I]
660 ECA[I]= ( YTCA[I] / T[I] ) - 1
664 ET[I]= O[1,1] * L[I]^O[2,1]
666 PERET[I]=  (ET[I]/CY[I]) - 1
667 ERR1= ERR1 + PERET[I]^2
670 NEXT I
671 ERR1= SQR(ERR1/N)
720  REM F-CALC ROUTINE ************************
730  J = 3
740  K =N
750  N = INT( K/2 )
760  SSET = SSE
770  GOSUB 2950
780  SSEL = SSE
790  FOR I = 1 TO K
800  U[I]=X[I]
810  V[I]=Y[I]
820  NEXT I
830  FOR I = (N+1) TO K
840  X[I-N]= U[I]
850  Y[I-N]= V[I]
860  NEXT I
870  N=K-N
880  GOSUB 2950
890  SSEU=SSE
970  N=K
980  FCALC[1]= SSET-SSEL-SSEU
990  FCALC[1]= FCALC[1] / (SSEL+SSEU)
```

```
1000  FCALC[1]= FCALC[1]* (N-4) / 2
1010  DATA 49.5,9.0,5.46,4.32,3.78,3.46,3.26,3.11,3.01
1020  DATA 2.92,2.86,2.81
1030  FOR I = 1 TO 12
1040  READ FTAB
1050  IF I = N-4 GOTO 1070
1060  NEXT I
1070 J=3
1071 FOR I= 1 TO N
1072 X[I]=(LPP[I])
1073 Y[I]=LOG(AY[I])
1074 NEXT I
1080 GOSUB 2950
1090 B= O[2,3]
1100 B1= B+1
1110 IN = 1/B
1120 FOR I = 1 TO N
1130 X[I]= L[I]^B1
1140 X[I] = X[I]- (F[I]-1)^B1
1150 X[I]= X[I]/B1
1160 X[I]= X[I]/ (L[I]-F[I]+1)
1170 X[I]= X[I]^IN
1180 LPP[I]=X[I]
1190 X[I]= LOG( X[I] )
1200 NEXT I
1210 J=2
1220 GOSUB 2950
1230 T1=O[1,2]
1240 SL=O[2,2]
1250 FOR I= 1 TO N
1260 YTPP[I]=T1 * LPP[I]^SL
1270 YTPP[I]= YTPP[I] * (L[I]-F[I]+1)
1280 EPP[I]= ( YTPP[I] / T[I] ) -1
1281 CUMT= CUMT + YTPP[I]
1282 CA[I]= CUMT/L[I]
1283 PERCA[I]= (CA[I]/CY[I])-1
1284 ERR2= ERR2+PERCA[I]^2
1290 NEXT I
1291 ERR2= SQR(ERR2/N)
1300 FOR I = 1 TO N
1310 CAPER=CAPER+(ECA[I]^2 )
1320 LPPER=LPPER+(EPP[I]^2 )
1330 NEXT I
1340 CAPER=SQR(CAPER /N )
1350 LPPER=SQR(LPPER / N )
1360 O[1,2] = T1/ (SL +1)
1370 REM F-CALC ROUTINE ************************
1380 J = 3
1390 K =N
1400 N = INT( K/2 )
1410 SSET = SSE
1420 GOSUB 2950
```

```
1430 SSEL = SSE
1440 FOR I = 1 TO K
1450 U[I]=X[I]
1460 V[I]=Y[I]
1470 NEXT I
1480 FOR I = (N+1) TO K
1490 X[I-N]= U[I]
1500 Y[I-N]= V[I]
1510 NEXT I
1520 N=K-N
1530 GOSUB 2950
1540 SSEU=SSE
1620 N=K
1630 FCALC[2]= SSET-SSEL-SSEU
1640 FCALC[2]= FCALC[2] / (SSEL+SSEU)
1650 FCALC[2]= FCALC[2]* (N-4) / 2
1710 PRINT
1720 PRINT "      SUMMARY  COST  INPUT  DATA      "
1730 PRINT "     ";
1740 PRINT USING F1$;"   LOT","LOT AVG","CUM AVG"
1750 FOR I = 1 TO N
1760 PRINT USING F2$;I,AY[I],CY[I]
1770 PRINT
1780 NEXT I
1781 INPUT "  PRESS RETURN TO CONTINUE";V$
1790 PRINT
1800 PRINT "  FITTING THE CUM AVERAGE","
1810 FOR I=1 TO 5
1820 PRINT USING F1$;T$[I],
1830 PRINT USING F2$;O[I,1]
1840 PRINT
1850 NEXT I
1860 PRINT "  FITTING THE LOT AVERAGE"
1870 FOR I=1 TO 5
1880 PRINT USING F1$;T$[I],
1890 PRINT USING F2$;O[I,2]
1900 PRINT
1910 NEXT I
1920 PRINT
1930 INPUT "  PRESS RETURN TO CONTINUE";A$
1940 PRINT USING
F1$;"FIRST","LAST","LPP","LOT","ET","%","CA",
1950 PRINT USING F1$;"%"
1960 PRINT USING F1$;"UNIT","UNIT","
","TOTAL","EST","ERR","EST",
1970 PRINT USING F1$;"ERR"
1980 PRINT
1990 FOR I =1 TO N
2000 PRINT USING F2$;F[I],L[I],LPP[I],T[I],YTCA[I],ECA[I],
2010 PRINT USING F2$;YTPP[I],EPP[I]
2020 NEXT I
2021 LPRINT
```

```
2022 LPRINT "              SUMMARY COST INPUT DATA          "
2050 LPRINT "      ";
2060 LPRINT "   LOT    LOT AVG   CUM AVG      ET CUM AVG
%ERROR    CALOT CUM AVG   % ERROR"
2080 FOR I = 1 TO N
2090 LPRINT USING F2$; I,AY[I],CY[I],
2091 LPRINT USING F6$; ET[I],
2092 LPRINT USING F2$; PERET[I],
2093 LPRINT USING F6$; CA[I],
2094 LPRINT USING F2$; PERCA[I]
2110 NEXT I
2111 LPRINT
2112 LPRINT "     STANDARD ERROR",
2113 LPRINT USING F1$; " "," ",
2114 LPRINT USING F3$; ERR1,
2115 LPRINT USING F5$; " ",
2117 LPRINT USING F8$; ERR2
2130 LPRINT "FITTING WITH E.T.",
2132 LPRINT "FITTING WITH CALOT"
2134 LPRINT
2140 FOR I=1 TO 5
2150 LPRINT USING F1$;T$[I],
2160 LPRINT USING F2$;O[I,1],
2161 LPRINT USING F1$;" ",
2162 LPRINT USING F2$;O[I,2]
2180 NEXT I
2280 LPRINT "  ";
2290 LPRINT USING
F1$;"FIRST","LAST","LPP","LOT","ET","%","CA",
2300 LPRINT USING F1$;"%"
2301 LPRINT "  ";
2310 LPRINT USING F1$;"UNIT","UNIT"," ","TOTAL","EST","ERR",
2320 LPRINT USING F1$;"EST","ERR"
2330 LPRINT
2340 FOR I =1 TO N
2350 LPRINT USING F2$;F[I],L[I],LPP[I],T[I],YTCA[I],ECA[I],
2360 LPRINT USING F2$;YTPP[I],EPP[I]
2370 NEXT I
2380 LPRINT
2385 LPRINT "     STANDARD ERROR",
2390 LPRINT USING F1$;" "," ",
2395 LPRINT USING F7$;" ",
2400 LPRINT USING F3$;CAPER,
2410 LPRINT USING F1$;" ",
2420 LPRINT USING F10$;LPPER
2430 LPRINT
2440 INPUT "  DO YOU WANT TO SEE THE SPLIT - F TEST";F$
2450 IF F$>= "Y" GOTO 2460 ELSE 2560
2460 PRINT "   ";
2470 PRINT USING F1$;"F-CALC","F-TABLE";"(90%)","CUM AVG
FIT"
2480 PRINT
```

```
2490 PRINT USING F2$;FCALC[1],FTAB
2500 PRINT
2510 LPRINT "    ";
2520 LPRINT "CURVE FIT WITH ELEMENTARY TECHNIQUE",
2521 LPRINT USING F1$;"F-CALC","F-TABLE";"(90%)"
2530 LPRINT
2535 LPRINT USING F9$; "   ",
2540 LPRINT USING F2$;FCALC[1],FTAB
2541 LPRINT
2542 PRINT "    ";
2543 PRINT USING F1$;"F-CALC","F-TABLE";"(90%)","LOT AVG
FIT"
2544 PRINT
2545 PRINT USING F2$;FCALC[2],FTAB
2546 PRINT
2547 LPRINT "    ";
2548 LPRINT "CURVE FIT WITH THE CALOT TECHNIQUE ",
2549 LPRINT USING F1$;"F-CALC","F-TABLE";"(90%)"
2550 LPRINT
2551 LPRINT USING F9$; " ",
2552 LPRINT USING F2$;FCALC[2],FTAB
2553 LPRINT
2560 INPUT "  DO YOU WANT A PREDICTION";A$
2570 IF A$ >= "Y" GOTO 2580 ELSE 2850
2580 INPUT"  FIRST UNIT,LAST UNIT FOR PREDICT";FU,LU
2590 LPRINT
2600 LPRINT "  FIRST UNIT, LAST UNIT FOR PREDICT  ";FU,LU
2610 LPRINT
2620 S=(FU-1)^(O[2,1]+1)
2630 E=LU^(O[2,1]+1)
2640 PRED=O[1,1]*(E-S)
2650 B2 = SL +1
2660 LOT= LU^B2
2670 LOT = LOT - (FU-1)^B2
2680 LOT=LOT/(B2)
2690 LOT=LOT/(LU-FU+1)
2700 PRED2 = T1 * LOT * ( LU-FU+1 )
2710 PRINT USING F1$;T$[6];" CUM AVG FIT",
2720 LPRINT "  PREDICTION WITH ELEMENTARY TECHNIQUE",
2730 PRINT USING F2$;PRED
2740 LPRINT USING F2$;PRED
2750 PRINT
2760 LPRINT
2770 PRINT
2790 PRINT USING F1$;T$[6];" LOT AVG FIT",
2800 LPRINT "  PREDICTION WITH CALOT TECHNIQUE     ",
2810 PRINT USING F2$;PRED2
2820 LPRINT USING F2$;PRED2
2830 INPUT "   DO YOU WANT ANOTHER PREDICTION";A$
2840 IF A$ >= "Y" GOTO 2580
2850 INPUT " DO YOU WISH TO SAVE THE INPUT DATA  ";S$
2860 IF S$ >= "Y" GOTO 2870 ELSE 2930
```

```
2870 INPUT "  DATA SET NAME  ";N$
2880 CLOSE
2890 OPEN "O",1,N$
2900 FOR I= 1 TO N
2910 WRITE# 1, F[I],L[I],T[I]
2920 NEXT I
2930 ERC%=DEFLPRINT("[NUL]")
2940 END
2950 AVX=0
2960 COX=0
2970 AVY=0
2980 COY=0
2990 COXY=0
3000 UN=0
3010 FOR I=1 TO N
3020 AVX=AVX+X[I]
3030 COX=COX+X[I]^2
3040 AVY=AVY+Y[I]
3050 COY=COY+Y[I]^2
3060 COXY=COXY+X[I]*Y[I]
3070 NEXT I
3080 AVX=AVX/N
3090 AVY=AVY/N
3100 COX=COX-N*AVX^2
3110 COY=COY-N*AVY^2
3120 COXY=COXY-N*AVX*AVY
3130 O[2,J]=COXY/COX
3140 O[1,J]=AVY-O[2,J]*AVX
3150 FOR I = 1 TO N
3160 YEST= O[1,J] + O[2,J] * X[I]
3170 UN = UN + ( Y[I] - YEST )^2
3180 NEXT I
3190 SSE = UN
3191 IF N <= 2 GO TO 3208
3200 UN=UN/(N-2)
3205 GO TO 3210
3208 UN = 0
3210 O[5,J]=SQR (ABS(UN))
3220 O[4,J]= 1 - ( UN/COY )
3230 O[1,J]=EXP(O[1,J])
3240 O[3,J]=2^O[2,J]*100
3250 RETURN
```

Appendix B: Total System Runs

This appendix provides the computer outputs from fitting the total systems for 66 programs. The total system costs have been fitted with the ET and Calot fitting techniques. The computer outputs provide the total fitted lot costs as estimated by ET and Calot.

A-3D 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	25.40	25.40	27.57	0.09	28.44	0.12
2.00	16.74	17.98	15.36	-0.15	15.19	-0.16
3.00	7.42	10.27	10.35	0.01	9.96	-0.03
4.00	5.40	7.39	7.91	0.07	7.47	0.01
STANDARD ERROR				0.092		0.099

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	33.97	35.39
EXPONENT	-0.30	-0.32
SLOPE	81.18	80.04
R SQR	0.98	0.97
STD ERR EST	0.13	0.21

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	2.00	0.59	50.80	55.15	0.09	56.89	0.12
3.00	14.00	6.80	200.90	159.83	-0.20	155.74	-0.22
15.00	52.00	30.33	282.10	323.09	0.15	305.17	0.08
53.00	127.00	85.84	405.00	466.49	0.15	431.24	0.06
STANDARD ERROR					0.153		0.138

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

A-4 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	12.60	12.60	14.07	0.12	14.58	0.16
2.00	8.14	8.59	7.03	-0.18	6.59	-0.23
3.00	3.53	6.06	5.70	-0.06	5.19	-0.14
4.00	2.29	3.34	3.88	0.16	3.34	0.00
STANDARD ERROR				0.138		0.158

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	14.07	14.50
EXPONENT	-0.30	-0.34
SLOPE	81.14	78.82
R SQR	0.96	0.95
STD ERR EST	0.20	0.29

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	1.00	0.29	12.60	14.07	0.1.	14.58	0.16
2.00	10.00	4.45	73.30	56.23	-0.23	51.32	-0.30
11.00	20.00	14.61	35.30	43.79	0.24	37.91	0.07
21.00	72.00	42.36	119.00	165.06	0.39	136.79	0.15
STANDARD ERROR					0.262		0.189

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

A-5 'S CUMULATIVE AVERAGE LEARNING CURVE

SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	18.34	18.34	18.18	-0.01	17.64	-0.04
2.00	13.49	15.62	15.65	0.00	15.61	-0.00
3.00	10.31	12.04	12.74	0.06	13.20	0.10
4.00	14.79	12.61	12.22	-0.03	12.76	0.01
5.00	9.31	11.97	11.75	-0.02	12.36	0.03
STANDARD ERROR				0.031		0.049

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	28.15	25.19
EXPONENT	-0.18	-0.15
SLOPE	88.12	90.20
R SQR	0.99	0.85
STD ERR EST	0.04	0.21

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	11.00	3.72	201.70	199.93	-0.01	194.05	-0.04
12.00	25.00	17.46	188.90	191.26	0.01	196.23	0.04
26.00	77.00	48.28	536.30	590.13	0.10	626.50	0.17
78.00	97.00	86.78	295.80	203.89	-0.31	220.84	-0.25
98.00	120.00	108.27	214.20	225.20	0.05	245.75	0.15
STANDARD ERROR					0.148		0.153

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.96	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	0.06	49.50	

A-6 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	15.99	15.99	16.20	0.01	16.23	0.02
2.00	10.18	12.51	12.43	-0.01	12.45	-0.00
3.00	7.87	10.02	9.97	-0.01	9.97	-0.01
4.00	6.73	8.50	8.33	-0.02	8.33	-0.02
5.00	5.33	7.31	7.27	-0.00	7.28	-0.00
6.00	4.43	6.35	6.47	0.02	6.47	0.02
7.00	4.43	5.64	5.67	0.00	5.67	0.00
8.00	4.05	5.37	5.37	-0.00	5.37	-0.00
STANDARD ERROR				0.011		0.012

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	29.54	29.53
EXPONENT	-0.29	-0.29
SLOPE	81.86	81.86
R SQR	1.00	1.00
STD ERR EST	0.01	0.05

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	8.00	2.44	127.90	129.61	0.01	129.86	0.02
9.00	20.00	13.42	122.20	119.07	-0.03	119.06	-0.03
21.00	43.00	30.56	180.90	179.93	-0.01	179.91	-0.01
44.00	80.00	60.27	248.90	237.91	-0.04	237.87	-0.04
81.00	128.00	102.79	255.60	264.54	0.03	264.50	0.03
129.00	192.00	158.60	283.50	311.19	0.10	311.14	0.10
193.00	304.00	245.23	496.20	480.17	-0.03	480.09	-0.03
305.00	367.00	334.86	255.00	246.86	-0.03	246.81	-0.03
STANDARD ERROR					0.044		0.044

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	3.53	4.32	
CURVE FIT WITH THE CALOT TECHNIQUE	2.71	4.32	

A-7A 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	9.43	9.43	9.20	-0.02	8.72	-0.08
2.00	5.38	7.11	6.99	-0.02	6.77	-0.05
3.00	2.95	3.65	3.90	0.07	3.96	0.09
4.00	1.82	2.21	2.35	0.06	2.49	0.13
5.00	1.89	2.05	1.88	-0.08	2.03	-0.01
STANDARD ERROR				0.058		0.081

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	13.16	12.07
EXPONENT	-0.33	-0.30
SLOPE	79.81	81.33
R SQR	1.00	0.99
STD ERR EST	0.08	0.17

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	3.00	0.91	28.30	27.61	-0.02	26.15	-0.08
4.00	7.00	4.82	21.50	21.29	-0.01	21.21	-0.01
8.00	42.00	21.33	103.30	114.86	0.11	119.12	0.15
43.00	199.00	107.93	286.20	303.91	0.06	329.52	0.15
200.00	395.00	289.77	370.90	274.98	-0.26	306.45	-0.17
STANDARD ERROR					0.130		0.128

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.77	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	1.00	49.50	

A-10A 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	9.95	9.95	10.01	0.01	10.00	0.00
2.00	5.75	6.65	6.53	-0.02	6.51	-0.02
3.00	3.97	5.26	5.33	0.01	5.32	0.01
4.00	3.63	4.57	4.57	-0.00	4.56	-0.00
STANDARD ERROR				0.011		0.012

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	16.46	16.39
EXPONENT	-0.28	-0.28
SLOPE	82.49	82.51
R SQR	1.00	1.00
STD ERR EST	0.02	0.05

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	6.00	1.84	59.70	60.05	0.01	60.00	0.00
7.00	28.00	15.27	126.40	122.66	-0.03	122.30	-0.03
29.00	58.00	41.84	119.20	126.47	0.06	126.10	0.06
59.00	101.00	78.23	156.30	152.37	-0.03	151.94	-0.03
STANDARD ERROR					0.036		0.036

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

AH-1G 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.98	0.98	0.98	-0.00	0.96	-0.02
2.00	0.60	0.68	0.69	0.02	0.70	0.04
3.00	0.54	0.62	0.62	-0.01	0.64	0.02
4.00	0.52	0.62	0.61	-0.01	0.63	0.02
STANDARD ERROR				0.010		0.025

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	2.79	2.49
EXPONENT	-0.22	-0.20
SLOPE	85.67	86.90
R SQR	1.00	0.99
STD ERR EST	0.01	0.05

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	110.00	35.78	107.84	107.39	-0.00	105.83	-0.02
111.00	530.00	288.62	250.08	256.92	0.03	264.74	0.06
531.00	838.00	676.92	164.95	155.73	-0.06	163.36	-0.01
839.00	876.00	856.89	19.77	18.23	-0.08	19.21	-0.03
STANDARD ERROR					0.050		0.034

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

AIM-7F (GD) 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	1.55	1.55	1.42	-0.08	1.36	-0.12
2.00	0.38	0.59	0.64	0.09	0.62	0.07
3.00	0.23	0.33	0.36	0.08	0.36	0.08
4.00	0.19	0.27	0.28	0.01	0.28	0.03
5.00	0.13	0.19	0.18	-0.03	0.19	0.00
6.00	0.09	0.14	0.13	-0.05	0.14	-0.01
STANDARD ERROR				0.063		0.068

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	5.00	4.48
EXPONENT	-0.46	-0.44
SLOPE	72.49	73.49
R SQR	1.00	1.00
STD ERR EST	0.08	0.15

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	15.00	3.90	23.27	21.35	-0.08	20.38	-0.12
16.00	85.00	43.02	26.53	32.73	0.23	32.73	0.23
86.00	295.00	174.53	47.88	51.25	0.07	52.69	0.10
296.00	505.00	393.14	40.95	35.16	-0.14	36.73	-0.10
506.00	1,255.00	838.99	97.50	88.32	-0.09	93.67	-0.04
1,256.00	2,565.00	1,853.38	117.90	106.78	-0.09	115.04	-0.02
STANDARD ERROR					0.132		0.124

CURVE FIT WITH ELEMENTARY TECHNIQUE	F-CALC	F-TABLE	(90%)
	5.47	9.00	

CURVE FIT WITH THE CALOT TECHNIQUE	F-CALC	F-TABLE	(90%)
	2.25	9.00	

AIM-7F (RAY) 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.74	0.74	0.75	0.01	0.74	-0.01
2.00	0.38	0.49	0.47	-0.04	0.47	-0.05
3.00	0.20	0.30	0.31	0.03	0.31	0.04
4.00	0.17	0.24	0.24	0.02	0.25	0.02
5.00	0.13	0.20	0.20	0.01	0.20	0.02
6.00	0.12	0.17	0.17	0.00	0.17	0.02
7.00	0.11	0.16	0.16	-0.01	0.16	0.01
8.00	0.10	0.15	0.15	-0.01	0.15	0.01
STANDARD ERROR				0.021		0.025

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	4.57	4.28
EXPONENT	-0.39	-0.38
SLOPE	76.13	76.65
R SQR	1.00	1.00
STD ERR EST	0.02	0.07

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	100.00	27.87	74.10	74.69	0.01	73.65	-0.01
101.00	325.00	197.48	85.05	77.99	-0.08	78.19	-0.08
326.00	925.00	589.24	119.40	135.29	0.13	137.09	0.15
926.00	1,725.00	1,296.16	135.20	132.30	-0.02	135.09	-0.00
1,726.00	2,825.00	2,243.51	147.40	146.60	-0.01	150.50	0.02
2,826.00	4,225.00	3,492.25	162.40	156.78	-0.03	161.65	-0.00
4,226.00	5,125.00	4,664.85	99.90	89.94	-0.10	92.99	-0.07
5,126.00	6,269.00	5,683.54	108.68	105.77	-0.03	109.58	0.01
STANDARD ERROR					0.068		0.065

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.70	4.32	
CURVE FIT WITH THE CALOT TECHNIQUE	0.35	4.32	

ARC-54 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	21.00	21.00	20.80	-0.01	20.47	-0.03
2.00	16.50	18.81	19.05	0.01	18.85	0.00
3.00	16.40	17.75	17.65	-0.01	17.54	-0.01
4.00	14.50	16.87	16.93	0.00	16.87	-0.00
5.00	14.40	16.71	16.78	0.00	16.73	0.00
6.00	13.90	15.58	15.68	0.01	15.69	0.01
7.00	14.30	15.25	15.08	-0.01	15.13	-0.01
STANDARD ERROR				0.008		0.011

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	50.91	47.45
EXPONENT	-0.13	-0.12
SLOPE	91.28	91.79
R SQR	1.00	0.99
STD ERR EST	0.01	0.04

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	900.00	309.10	18,900.00	18,716.18	-0.01	18,419.34	-0.03
901.00	1,753.00	1,300.14	14,074.50	14,676.13	0.04	14,616.27	0.04
1,754.00	3,134.00	2,406.22	22,648.40	21,911.15	-0.03	21,929.25	-0.03
3,135.00	4,294.00	3,696.92	16,820.00	17,393.08	0.03	17,467.34	0.04
4,295.00	4,594.00	4,442.69	4,320.00	4,390.74	0.02	4,415.93	0.02
4,595.00	7,697.00	6,070.94	43,131.70	43,586.25	0.01	43,945.51	0.02
7,698.00	10,347.00	8,985.49	37,895.00	35,350.69	-0.07	35,753.86	-0.06
STANDARD ERROR					0.036		0.035

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.43	5.46	
CURVE FIT WITH THE CALOT TECHNIQUE	2.01	5.46	

ARC-109V 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	48.70	48.70	48.62	-0.00	48.09	-0.01
2.00	39.30	40.64	39.41	-0.03	39.39	-0.03
3.00	28.50	31.68	34.09	0.08	34.33	0.08
4.00	31.30	31.42	30.16	-0.04	30.55	-0.03
STANDARD ERROR				0.046		0.047

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	56.48	55.43
EXPONENT	-0.11	-0.10
SLOPE	92.79	93.14
R SQR	0.97	0.92
STD ERR EST	0.06	0.11

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	4.00	1.39	194.80	194.50	-0.00	192.35	-0.01
5.00	28.00	14.05	943.20	908.87	-0.04	910.47	-0.03
29.00	107.00	62.86	2,251.50	2,544.62	0.13	2,570.14	0.14
108.00	333.00	208.60	7,073.80	6,394.78	-0.10	6,501.48	-0.08
STANDARD ERROR					0.083		0.084

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

ASN-108 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	13.75	13.75	13.29	-0.03	13.05	-0.05
2.00	10.48	11.15	11.39	0.02	11.34	0.02
3.00	8.74	9.55	10.24	0.07	10.29	0.08
4.00	9.43	9.47	9.24	-0.02	9.37	-0.01
5.00	8.72	9.29	8.99	-0.03	9.13	-0.02
STANDARD ERROR				0.041		0.043

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	16.27	15.71
EXPONENT	-0.10	-0.09
SLOPE	93.47	94.01
R SQR	0.98	0.95
STD ERR EST	0.05	0.08

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	8.00	2.81	110.00	106.31	-0.03	104.43	-0.05
9.00	39.00	21.41	325.00	337.86	0.04	337.65	0.04
40.00	116.00	73.81	673.00	743.89	0.11	751.16	0.12
117.00	332.00	213.99	2,037.00	1,881.25	-0.08	1,916.55	-0.06
333.00	440.00	384.62	942.00	888.39	-0.06	909.52	-0.03
STANDARD ERROR					0.068		0.067

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	35.21	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	2.23	49.50	

ASQ-133 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	58.57	58.57	61.08	0.04	62.76	0.07
2.00	58.63	58.61	54.95	-0.06	55.82	-0.05
3.00	42.54	47.79	47.86	0.00	47.92	0.00
4.00	38.28	44.00	44.94	0.02	44.71	0.02
STANDARD ERROR				0.039		0.044

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	84.61	89.92
EXPONENT	-0.12	-0.14
SLOPE	91.80	90.98
R SQR	0.95	0.90
STD ERR EST	0.06	0.12

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	14.00	4.77	820.00	855.14	0.04	878.63	0.07
15.00	33.00	22.74	1,114.00	958.04	-0.14	963.56	-0.14
34.00	101.00	63.50	2,893.00	3,020.33	0.04	2,997.87	0.04
102.00	168.00	132.89	2,565.00	2,716.77	0.06	2,670.78	0.04
STANDARD ERROR					0.082		0.081

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

ASW-32 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	23.42	23.42	23.37	-0.00	23.02	-0.02
2.00	16.42	18.63	18.84	0.01	18.72	0.00
3.00	15.25	16.74	16.17	-0.03	16.17	-0.03
4.00	9.75	14.24	14.88	0.05	14.93	0.05
5.00	14.42	14.29	14.03	-0.02	14.11	-0.01
STANDARD ERROR				0.027		0.028

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	37.21	35.93
EXPONENT	-0.19	-0.18
SLOPE	87.84	88.31
R SQR	0.99	0.90
STD ERR EST	0.03	0.19

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	12.00	3.97	281.00	280.49	-0.00	276.30	-0.02
13.00	38.00	23.57	427.00	435.42	0.02	435.07	0.02
39.00	86.00	60.10	732.00	674.70	-0.08	679.13	-0.07
87.00	134.00	108.95	468.00	603.62	0.29	610.42	0.30
135.00	184.00	158.22	721.00	586.38	-0.19	594.72	-0.18
STANDARD ERROR					0.158		0.161

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.07	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	0.01	49.50	

B-52 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	112.50	112.50	106.21	-0.06	100.60	-0.11
2.00	37.00	60.97	64.20	0.05	62.32	0.02
3.00	28.60	51.77	55.45	0.07	54.24	0.05
4.00	32.30	42.69	42.08	-0.01	41.80	-0.02
5.00	23.40	34.08	32.47	-0.05	32.74	-0.04
STANDARD ERROR				0.052		0.056

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	395.33	339.96
EXPONENT	-0.44	-0.41
SLOPE	73.78	75.19
R SQR	0.99	0.98
STD ERR EST	0.07	0.19

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	20.00	5.32	2,250.00	2,124.18	-0.06	2,011.97	-0.11
21.00	63.00	38.61	1,591.00	1,920.47	0.21	1,914.50	0.20
64.00	88.00	75.00	715.00	834.52	0.17	847.06	0.18
89.00	165.00	123.61	2,487.10	2,064.28	-0.17	2,124.22	-0.15
166.00	298.00	226.80	3,112.20	2,732.04	-0.12	2,858.45	-0.08
STANDARD ERROR					0.153		0.151

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	19.06	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	1.30	49.50	

B-58 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	51.28	51.28	52.18	0.02	54.82	0.07
2.00	31.76	40.22	39.54	-0.02	40.12	-0.00
3.00	23.60	31.15	30.44	-0.02	29.95	-0.04
4.00	17.84	28.06	27.88	-0.01	27.15	-0.03
5.00	14.37	24.52	25.24	0.03	24.31	-0.01
STANDARD ERROR				0.020		0.038

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	122.22	138.93
EXPONENT	-0.33	-0.37
SLOPE	79.46	77.52
R SQR	1.00	0.99
STD ERR EST	0.03	0.11

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	13.00	3.61	666.70	678.39	0.02	712.65	0.07
14.00	30.00	20.68	539.90	507.82	-0.06	491.03	-0.09
31.00	66.00	46.36	849.50	822.76	-0.03	772.98	-0.09
67.00	86.00	75.69	356.90	388.69	0.09	358.67	0.00
87.00	116.00	100.48	431.00	530.73	0.23	484.83	0.12
STANDARD ERROR					0.115		0.086

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	24.53	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	22.11	49.50	

C-5A 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	197.60	197.60	201.95	0.02	203.37	0.03
2.00	111.73	144.75	139.39	-0.04	140.17	-0.03
3.00	65.92	98.98	99.49	0.01	100.10	0.01
4.00	52.24	77.22	78.03	0.01	78.58	0.02
5.00	46.56	68.51	68.54	0.00	69.07	0.01
STANDARD ERROR				0.020		0.022

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	377.08	373.41
EXPONENT	-0.39	-0.38
SLOPE	76.42	76.60
R SQR	1.00	1.00
STD ERR EST	0.03	0.08

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	5.00	1.37	988.00	1,009.74	0.02	1,016.85	0.03
6.00	13.00	8.56	893.80	802.33	-0.10	805.31	-0.10
14.00	31.00	21.09	1,186.50	1,272.24	0.07	1,280.88	0.08
32.00	58.00	43.51	1,410.50	1,441.17	0.02	1,454.39	0.03
59.00	81.00	69.05	1,070.80	1,026.41	-0.04	1,037.36	-0.03
STANDARD ERROR					0.061		0.062

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	22.38	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	35.90	49.50	

C-47 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	6.18	6.18	6.67	0.08	6.35	0.03
2.00	5.23	5.64	5.46	-0.03	5.35	-0.05
3.00	4.56	5.24	4.90	-0.07	4.88	-0.07
4.00	3.46	4.39	4.21	-0.04	4.28	-0.03
5.00	2.76	3.80	3.78	-0.01	3.91	0.03
6.00	2.31	3.13	3.28	0.05	3.46	0.11
7.00	2.31	2.98	3.12	0.05	3.32	0.11
8.00	2.70	2.91	2.92	0.00	3.14	0.08
9.00	3.46	2.95	2.87	-0.03	3.09	0.05
STANDARD ERROR				0.046		0.069

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	13.25	11.40
EXPONENT	-0.24	-0.20
SLOPE	84.83	86.90
R SQR	1.00	0.96
STD ERR EST	0.05	0.19

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	18.00	5.87	111.26	120.11	0.08	114.33	0.03
19.00	42.00	29.00	125.42	109.11	-0.13	110.29	-0.12
43.00	66.00	53.46	109.42	94.35	-0.14	97.43	-0.11
67.00	126.00	94.07	207.54	206.29	-0.01	217.23	0.05
127.00	198.00	160.37	198.72	218.11	0.10	233.97	0.18
199.00	358.00	273.27	369.12	427.12	0.16	466.70	0.26
359.00	442.00	399.11	194.29	204.95	0.05	226.92	0.17
443.00	585.00	511.49	385.39	328.95	-0.15	367.36	-0.05
586.00	630.00	607.33	155.84	99.38	-0.36	111.65	-0.28
STANDARD ERROR					0.161		0.164

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	3.43	3.78	
CURVE FIT WITH THE CALOT TECHNIQUE	2.81	3.78	

C-133 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	25.98	25.98	25.80	-0.01	25.63	-0.01
2.00	16.61	20.49	21.01	0.03	21.39	0.04
3.00	19.67	20.35	20.11	-0.01	20.59	0.01
4.00	14.63	18.63	18.51	-0.01	19.14	0.03
STANDARD ERROR				0.015		0.028

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	46.02	42.43
EXPONENT	-0.23	-0.20
SLOPE	85.09	86.84
R SQR	0.99	0.88
STD ERR EST	0.02	0.15

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	12.00	3.89	311.70	309.62	-0.01	307.51	-0.01
13.00	29.00	19.75	282.40	299.64	0.06	312.94	0.11
30.00	35.00	31.94	118.00	94.54	-0.20	100.15	-0.15
36.00	50.00	42.23	219.50	221.49	0.01	236.55	0.08
STANDARD ERROR					0.104		0.101

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

CH-46 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	7.54	7.54	7.52	-0.00	7.45	-0.01
2.00	3.90	4.92	4.92	0.00	4.92	0.00
3.00	2.77	3.74	3.79	0.01	3.81	0.02
4.00	2.42	3.17	3.13	-0.01	3.16	-0.00
STANDARD ERROR				0.008		0.010

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	18.05	17.40
EXPONENT	-0.33	-0.32
SLOPE	79.44	79.91
R SQR	1.00	1.00
STD ERR EST	0.01	0.04

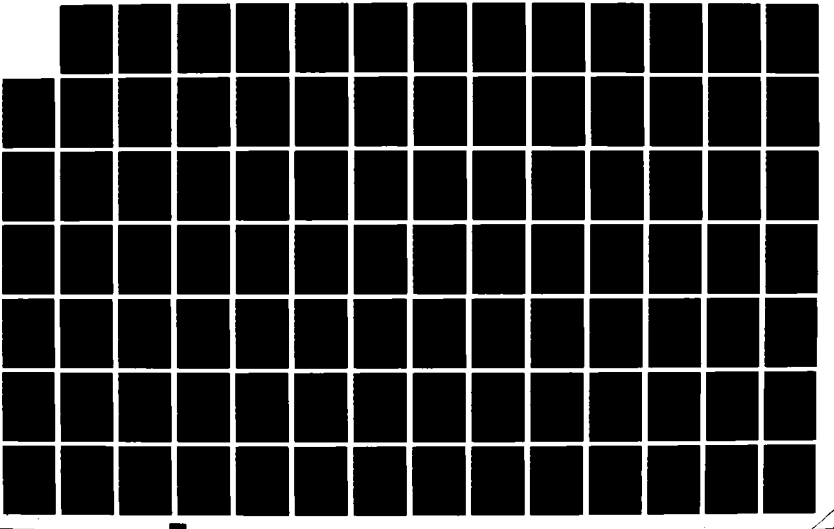
FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	14.00	4.11	105.57	105.22	-0.00	104.33	-0.01
15.00	50.00	29.52	140.33	141.02	0.00	141.69	0.01
51.00	110.00	77.39	165.96	170.71	0.03	172.89	0.04
111.00	195.00	149.79	205.62	194.22	-0.06	197.80	-0.04
STANDARD ERROR					0.031		0.029

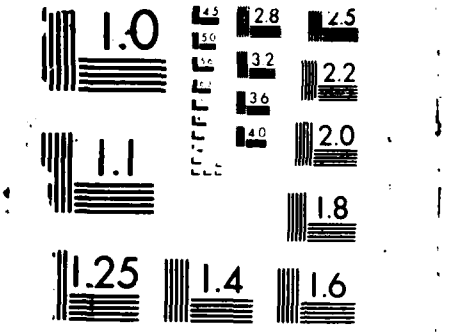
CURVE FIT WITH ELEMENTARY TECHNIQUE	F-CALC	F-TABLE	(90%)
	0.00	2.81	

CURVE FIT WITH THE CALOT TECHNIQUE	F-CALC	F-TABLE	(90%)
	0.00	2.81	

AD-A187 127 A COMPARISON OF FITTING TECHNIQUES FOR THE CUMULATIVE AVERAGE LEARNING CU..(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF SYST.. J K JONES 2/3

UNCLASSIFIED SEP 87 AFIT/GSM/LSQ/87S-11 F/G 12/1 NL

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EA-6B 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	10.66	10.66	10.61	-0.00	10.74	0.01
2.00	8.53	9.16	9.31	0.02	9.31	0.02
3.00	8.53	8.91	8.83	-0.01	8.78	-0.01
4.00	7.83	8.59	8.50	-0.01	8.43	-0.02
5.00	6.91	8.34	8.36	0.00	8.27	-0.01
6.00	7.20	8.21	8.25	0.00	8.15	-0.01
STANDARD ERROR				0.009		0.013

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	12.60	12.96
EXPONENT	-0.11	-0.12
SLOPE	92.87	92.23
R SQR	1.00	0.98
STD ERR EST	0.01	0.05

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	5.00	1.72	53.30	53.06	-0.00	53.70	0.01
6.00	17.00	10.34	102.40	105.27	0.03	104.57	0.02
18.00	28.00	22.25	93.80	88.93	-0.05	87.66	-0.07
29.00	40.00	33.80	94.00	92.78	-0.01	91.07	-0.03
41.00	47.00	43.45	48.40	52.69	0.09	51.59	0.07
48.00	53.00	49.96	43.20	44.50	0.03	43.51	0.01
STANDARD ERROR					0.046		0.041

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.33	9.00	
CURVE FIT WITH THE CALOT TECHNIQUE	0.70	9.00	

E-2C 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	11.82	11.82	11.80	-0.00	11.59	-0.02
2.00	9.51	10.85	10.84	-0.00	10.82	-0.00
3.00	8.49	10.09	10.22	0.01	10.30	0.02
4.00	9.67	10.01	9.91	-0.01	10.05	0.00
STANDARD ERROR				0.008		0.014

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	17.06	15.71
EXPONENT	-0.15	-0.13
SLOPE	89.88	91.59
R SQR	0.99	0.87
STD ERR EST	0.01	0.09

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	11.00	3.77	130.00	129.75	-0.00	127.52	-0.02
12.00	19.00	14.80	76.10	76.28	0.00	77.97	0.02
20.00	28.00	23.34	76.40	80.00	0.05	82.79	0.08
29.00	34.00	30.95	58.00	51.06	-0.12	53.25	-0.08
STANDARD ERROR					0.064		0.061

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

F-3D 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	7.83	7.83	7.57	-0.03	7.46	-0.05
2.00	3.64	4.09	4.43	0.08	4.49	0.10
3.00	3.25	3.59	3.56	-0.01	3.65	0.02
4.00	2.59	3.01	2.89	-0.04	2.99	-0.00
STANDARD ERROR				0.049		0.055

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	9.85	9.57
EXPONENT	-0.24	-0.23
SLOPE	84.71	85.44
R SQR	0.99	0.98
STD ERR EST	0.07	0.11

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	3.00	0.96	23.50	22.70	-0.03	22.39	-0.05
4.00	28.00	12.94	91.00	101.44	0.11	103.38	0.14
29.00	70.00	47.06	136.50	125.09	-0.08	129.55	-0.05
71.00	167.00	114.24	251.30	233.64	-0.07	244.64	-0.03
STANDARD ERROR					0.081		0.078

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

F-4 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	20.33	20.33	21.99	0.08	22.80	0.12
2.00	18.64	19.15	17.11	-0.11	17.10	-0.11
3.00	11.63	15.31	14.71	-0.04	14.39	-0.06
4.00	8.57	11.23	12.09	0.08	11.50	0.02
STANDARD ERROR				0.080		0.087

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	33.15	36.36
EXPONENT	-0.21	-0.24
SLOPE	86.39	84.62
R SQR	0.94	0.91
STD ERR EST	0.11	0.21

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	7.00	2.21	142.30	153.92	0.08	159.61	0.12
8.00	23.00	14.04	298.20	239.55	-0.20	233.64	-0.22
24.00	47.00	34.12	279.00	298.03	0.07	282.96	0.01
48.00	119.00	79.58	616.90	747.66	0.21	692.17	0.12
STANDARD ERROR					0.154		0.139

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

F-5 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	5.20	5.20	5.42	0.04	5.41	0.04
2.00	3.31	3.67	3.40	-0.07	3.43	-0.07
3.00	1.56	1.85	1.93	0.05	1.98	0.07
4.00	1.33	1.58	1.56	-0.01	1.61	0.02
STANDARD ERROR				0.049		0.053

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	8.54	8.42
EXPONENT	-0.28	-0.28
SLOPE	82.20	82.60
R SQR	0.99	0.99
STD ERR EST	0.07	0.12

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	5.00	1.54	26.00	27.09	0.04	27.06	0.04
6.00	26.00	13.76	69.50	61.28	-0.12	62.16	-0.11
27.00	192.00	92.77	258.90	282.35	0.09	290.28	0.12
193.00	406.00	290.54	285.10	263.58	-0.08	273.15	-0.04
STANDARD ERROR					0.086		0.086

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

F-6 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	17.25	17.25	18.32	0.06	18.55	0.08
2.00	9.21	10.45	9.48	-0.09	9.63	-0.08
3.00	2.89	3.29	3.39	0.03	3.46	0.05
4.00	2.04	2.77	2.79	0.01	2.86	0.03
STANDARD ERROR				0.057		0.062

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	23.38	23.55
EXPONENT	-0.35	-0.35
SLOPE	78.36	78.50
R SQR	1.00	0.99
STD ERR EST	0.08	0.12

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	2.00	0.58	34.50	36.64	0.06	37.10	0.08
3.00	13.00	6.42	101.30	86.64	-0.14	88.05	-0.13
14.00	243.00	95.91	664.70	699.48	0.05	715.91	0.08
244.00	421.00	326.49	363.60	352.14	-0.03	361.20	-0.01
STANDARD ERROR					0.084		0.085

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

F-14 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	50.37	50.37	50.71	0.01	50.35	-0.00
2.00	27.20	38.78	38.23	-0.01	38.15	-0.02
3.00	17.06	23.92	23.89	-0.00	24.10	0.01
4.00	11.03	16.72	17.13	0.02	17.42	0.04
5.00	9.97	14.31	14.30	-0.00	14.60	0.02
6.00	8.56	12.75	12.56	-0.01	12.88	0.01
STANDARD ERROR				0.013		0.021

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	105.26	101.49
EXPONENT	-0.41	-0.40
SLOPE	75.39	75.99
R SQR	1.00	1.00
STD ERR EST	0.02	0.06

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	6.00	1.64	302.20	304.25	0.01	302.09	-0.00
7.00	12.00	8.76	163.20	154.47	-0.05	155.67	-0.05
13.00	38.00	23.28	443.50	449.28	0.01	457.95	0.03
39.00	86.00	59.72	529.30	565.00	0.07	582.12	0.10
87.00	134.00	108.75	478.70	442.56	-0.08	459.07	-0.04
135.00	184.00	158.06	428.20	395.82	-0.08	412.35	-0.04
STANDARD ERROR					0.056		0.052

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	3.67	9.00	
CURVE FIT WITH THE CALOT TECHNIQUE	2.13	9.00	

F-15A/B 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	25.60	25.60	25.48	-0.00	25.28	-0.01
2.00	19.56	21.53	21.61	0.00	21.61	0.00
3.00	17.18	19.62	19.85	0.01	19.94	0.02
4.00	17.13	18.63	18.43	-0.01	18.57	-0.00
STANDARD ERROR				0.009		0.010

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	42.01	40.66
EXPONENT	-0.15	-0.14
SLOPE	90.31	90.77
R SQR	1.00	0.99
STD ERR EST	0.01	0.04

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	30.00	10.19	767.91	764.40	-0.00	758.52	-0.01
31.00	92.00	57.80	1,212.47	1,223.71	0.01	1,230.02	0.01
93.00	164.00	126.03	1,237.18	1,267.16	0.02	1,280.94	0.04
165.00	272.00	215.41	1,849.61	1,756.70	-0.05	1,782.73	-0.04
STANDARD ERROR					0.028		0.027

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

F-16A/B 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	10.14	10.14	10.26	0.01	10.74	0.06
2.00	7.74	8.75	8.79	0.00	8.83	0.01
3.00	8.04	8.46	8.00	-0.05	7.83	-0.07
4.00	5.05	7.44	7.51	0.01	7.23	-0.03
5.00	5.13	7.06	7.27	0.03	6.94	-0.02
STANDARD ERROR				0.029		0.045

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	23.50	30.58
EXPONENT	-0.18	-0.23
SLOPE	88.39	85.55
R SQR	0.98	0.93
STD ERR EST	0.04	0.16

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	105.00	33.51	1,064.70	1,077.32	0.01	1,128.21	0.06
106.00	250.00	171.13	1,122.30	1,120.57	-0.00	1,079.23	-0.04
251.00	425.00	332.74	1,407.00	1,201.64	-0.15	1,121.38	-0.20
426.00	605.00	511.73	909.00	1,144.85	0.26	1,046.87	0.15
606.00	725.00	663.89	615.60	728.69	0.18	658.18	0.07
STANDARD ERROR					0.157		0.122

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	46.70	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	1.31	49.50	

F-84 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	2.20	2.20	2.26	0.03	2.22	0.01
2.00	1.30	1.52	1.43	-0.06	1.43	-0.06
3.00	0.75	1.07	1.07	0.00	1.08	0.01
4.00	0.57	0.85	0.88	0.04	0.90	0.06
5.00	0.69	0.81	0.80	-0.01	0.81	0.01
STANDARD ERROR				0.035		0.038

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	6.55	6.14
EXPONENT	-0.33	-0.32
SLOPE	79.55	80.27
R SQR	1.00	0.98
STD ERR EST	0.05	0.16

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	25.00	7.40	54.90	56.59	0.03	55.59	0.01
26.00	100.00	56.97	97.40	86.65	-0.11	87.32	-0.10
101.00	241.00	163.73	105.70	114.98	0.09	117.46	0.11
242.00	432.00	330.35	109.00	123.55	0.13	127.35	0.17
433.00	586.00	506.40	105.70	86.52	-0.18	89.67	-0.15
STANDARD ERROR					0.120		0.122

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	1.88	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	0.70	49.50	

F-89 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	11.70	11.70	12.63	0.08	12.72	0.09
2.00	7.38	7.55	6.29	-0.17	6.01	-0.20
3.00	3.82	5.46	5.26	-0.04	4.96	-0.09
4.00	2.98	4.30	4.59	0.07	4.28	-0.00
5.00	3.47	3.91	3.99	0.02	3.69	-0.06
6.00	2.53	3.50	3.70	0.06	3.39	-0.03
STANDARD ERROR				0.085		0.102

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	14.68	14.94
EXPONENT	-0.22	-0.23
SLOPE	86.06	85.09
R SQR	0.99	0.98
STD ERR EST	0.11	0.18

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	2.00	0.64	23.40	25.26	0.08	25.44	0.09
3.00	50.00	19.62	354.20	289.27	-0.18	274.95	-0.22
51.00	114.00	79.32	244.60	285.37	0.17	264.77	0.08
115.00	214.00	160.78	298.30	382.65	0.28	350.94	0.18
215.00	407.00	304.16	670.50	643.27	-0.04	583.85	-0.13
408.00	579.00	489.88	435.80	517.08	0.19	465.66	0.07
STANDARD ERROR					0.175		0.140

CURVE FIT WITH ELEMENTARY TECHNIQUE	F-CALC	F-TABLE	(90%)
	1.69	9.00	
CURVE FIT WITH THE CALOT TECHNIQUE	F-CALC	F-TABLE	(90%)
	0.16	9.00	

F-100 AIRFRAME 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	3.22	3.22	3.14	-0.03	3.02	-0.06
2.00	2.12	2.46	2.60	0.05	2.61	0.06
3.00	2.20	2.35	2.37	0.01	2.43	0.04
4.00	2.01	2.25	2.25	-0.00	2.34	0.04
5.00	2.25	2.25	2.19	-0.03	2.29	0.01
STANDARD ERROR				0.031		0.046

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	7.44	5.87
EXPONENT	-0.16	-0.12
SLOPE	89.36	91.70
R SQR	0.98	0.92
STD ERR EST	0.04	0.11

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	203.00	69.66	654.60	637.26	-0.03	613.84	-0.06
204.00	654.00	404.59	955.30	1,060.62	0.11	1,094.56	0.15
655.00	1,150.00	888.96	1,092.20	1,026.27	-0.06	1,090.97	-0.00
1,151.00	1,594.00	1,365.23	891.30	856.82	-0.04	925.61	0.04
1,595.00	1,889.00	1,739.18	665.00	547.33	-0.18	596.66	-0.10
STANDARD ERROR					0.099		0.086

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	17.24	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	1.89	49.50	

F-100 ENGINE 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	3.75	3.75	3.77	0.00	3.79	0.01
2.00	3.21	3.45	3.46	0.00	3.46	0.00
3.00	2.99	3.21	3.19	-0.01	3.19	-0.01
4.00	2.76	3.03	3.02	-0.00	3.01	-0.01
5.00	2.55	2.83	2.85	0.01	2.84	0.00
STANDARD ERROR				0.005		0.006

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	5.85	5.97
EXPONENT	-0.11	-0.11
SLOPE	92.79	92.56
R SQR	1.00	1.00
STD ERR EST	0.01	0.02

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	59.00	20.41	221.50	222.18	0.00	223.32	0.01
60.00	131.00	92.38	231.00	230.45	-0.00	230.27	-0.00
132.00	276.00	198.56	432.90	427.33	-0.01	425.78	-0.02
277.00	461.00	364.13	510.80	510.68	-0.00	507.69	-0.01
462.00	773.00	609.58	794.20	814.68	0.03	808.38	0.02
STANDARD ERROR					0.013		0.012

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	3.99	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	7.65	49.50	

F-101 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	16.85	16.85	15.99	-0.05	15.34	-0.09
2.00	7.58	10.08	11.08	0.10	10.90	0.08
3.00	6.91	7.77	7.69	-0.01	7.76	-0.00
4.00	5.76	7.11	6.88	-0.03	7.00	-0.02
STANDARD ERROR				0.058		0.061

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	41.81	37.42
EXPONENT	-0.28	-0.26
SLOPE	82.37	83.50
R SQR	0.99	0.96
STD ERR EST	0.08	0.16

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	31.00	9.67	522.35	495.77	-0.05	475.61	-0.09
32.00	115.00	67.41	636.72	778.59	0.22	777.57	0.22
116.00	424.00	249.01	2,135.19	1,986.88	-0.07	2,035.92	-0.05
425.00	630.00	522.70	1,186.56	1,076.18	-0.09	1,119.14	-0.06
STANDARD ERROR					0.128		0.125

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

F-102 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	34.55	34.55	32.63	-0.06	29.55	-0.14
2.00	5.17	12.67	14.04	0.11	13.07	0.03
3.00	3.50	5.38	5.28	-0.02	5.15	-0.04
4.00	2.21	4.86	4.72	-0.03	4.64	-0.05
STANDARD ERROR				0.063		0.080

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	303.21	220.24
EXPONENT	-0.62	-0.58
SLOPE	65.19	67.09
R SQR	1.00	0.98
STD ERR EST	0.09	0.30

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	37.00	7.38	1,278.42	1,207.46	-0.06	1,093.22	-0.14
38.00	145.00	81.21	558.36	828.97	0.48	801.75	0.44
146.00	707.00	367.61	1,967.00	1,697.59	-0.14	1,748.64	-0.11
708.00	847.00	775.27	309.40	267.30	-0.14	283.44	-0.08
STANDARD ERROR					0.262		0.240

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

F-105 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	10.60	10.60	11.30	0.07	11.43	0.08
2.00	10.74	10.64	10.06	-0.06	10.28	-0.03
3.00	6.19	8.76	8.41	-0.04	8.74	-0.00
4.00	4.48	6.78	6.87	0.01	7.27	0.07
5.00	4.02	5.75	5.89	0.03	6.32	0.10
6.00	3.83	5.19	5.27	0.02	5.72	0.10
7.00	4.91	5.18	5.18	0.00	5.63	0.09
8.00	4.19	5.05	4.95	-0.02	5.40	0.07
STANDARD ERROR				0.036		0.075

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	44.03	39.01
EXPONENT	-0.33	-0.29
SLOPE	79.78	81.52
R SQR	1.00	0.96
STD ERR EST	0.04	0.21

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	65.00	19.66	689.20	734.50	0.07	743.10	0.08
66.00	93.00	78.45	300.60	200.64	-0.33	212.84	-0.29
94.00	161.00	124.98	420.90	418.69	-0.01	450.60	0.07
162.00	300.00	225.82	622.80	705.82	0.13	773.65	0.24
301.00	480.00	385.41	724.10	767.89	0.06	855.77	0.18
481.00	675.00	573.88	747.40	730.66	-0.02	824.40	0.10
676.00	711.00	692.90	176.70	126.85	-0.28	143.97	-0.19
712.00	818.00	763.69	448.40	365.28	-0.19	415.82	-0.07
STANDARD ERROR					0.177		0.173

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.34	4.32	
CURVE FIT WITH THE CALOT TECHNIQUE	0.67	4.32	

F-106 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	42.29	42.29	41.24	-0.02	39.94	-0.06
2.00	10.54	20.80	21.89	0.05	22.01	0.06
3.00	11.64	18.44	18.53	0.00	18.85	0.02
4.00	7.59	13.18	12.77	-0.03	13.36	0.01
STANDARD ERROR				0.033		0.042

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	334.94	245.62
EXPONENT	-0.56	-0.50
SLOPE	67.81	70.53
R SQR	1.00	0.97
STD ERR EST	0.05	0.22

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	42.00	9.16	1,775.98	1,731.88	-0.02	1,677.06	-0.06
43.00	130.00	79.54	927.52	1,113.99	0.20	1,183.13	0.28
131.00	175.00	151.61	523.80	397.24	-0.24	437.17	-0.17
176.00	340.00	250.27	1,252.35	1,099.53	-0.12	1,245.28	-0.01
STANDARD ERROR					0.169		0.163

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

F-111 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	35.96	35.96	36.09	0.00	36.50	0.02
2.00	17.05	19.19	18.97	-0.01	18.58	-0.03
3.00	12.73	18.34	18.20	-0.01	17.79	-0.03
4.00	10.97	15.84	16.10	0.02	15.65	-0.01
STANDARD ERROR				0.011		0.024

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	84.74	88.62
EXPONENT	-0.30	-0.31
SLOPE	81.49	80.74
R SQR	1.00	1.00
STD ERR EST	0.02	0.05

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	18.00	5.36	647.30	649.64	0.00	657.02	0.02
19.00	159.00	73.17	2,404.20	2,366.24	-0.02	2,297.34	-0.04
160.00	183.00	170.81	305.50	314.08	0.03	301.04	-0.01
184.00	277.00	227.85	1,031.00	1,129.75	0.10	1,078.76	0.05
STANDARD ERROR					0.051		0.034

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

F-404 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	2.78	2.78	2.83	0.02	2.88	0.04
2.00	2.45	2.54	2.48	-0.02	2.47	-0.03
3.00	2.21	2.39	2.33	-0.03	2.30	-0.04
4.00	1.80	2.11	2.18	0.03	2.13	0.01
STANDARD ERROR				0.026		0.030

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	3.55	3.73
EXPONENT	-0.10	-0.12
SLOPE	93.10	92.10
R SQR	0.97	0.94
STD ERR EST	0.04	0.08

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	9.00	3.10	25.00	25.47	0.02	25.90	0.04
10.00	33.00	19.61	58.70	56.21	-0.04	55.48	-0.05
34.00	60.00	45.75	59.60	57.95	-0.03	56.44	-0.05
61.00	114.00	85.40	97.20	108.68	0.12	104.83	0.08
STANDARD ERROR					0.065		0.058

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

GBU-15 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	19.75	19.75	20.58	0.04	20.94	0.06
2.00	20.00	19.90	18.63	-0.06	18.92	-0.05
3.00	14.39	15.69	16.05	0.02	16.26	0.04
4.00	14.83	15.38	15.33	-0.00	15.52	0.01
5.00	13.08	14.66	14.74	0.01	14.91	0.02
STANDARD ERROR				0.036		0.059

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	30.10	30.85
EXPONENT	-0.10	-0.11
SLOPE	93.10	92.98
R SQR	0.97	0.94
STD ERR EST	0.05	0.09

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	40.00	13.89	790.00	823.13	0.04	857.76	0.08
41.00	105.00	69.68	1,300.00	1,132.93	-0.13	1,149.23	-0.12
106.00	445.00	253.56	4,893.00	5,187.02	0.06	5,248.58	0.07
446.00	695.00	564.90	3,708.00	3,511.73	-0.05	3,547.78	-0.04
696.00	1,015.00	849.44	4,186.00	4,309.86	0.03	4,350.66	0.04
STANDARD ERROR					0.072		0.072

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	16.80	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	1.90	49.50	

H-34 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	6,468.00	6,468.00	5,680.28	-0.12	5,150.93	-0.20
2.00	975.28	1,183.86	1,523.82	0.29	1,628.56	0.38
3.00	932.50	1,057.39	1,150.10	0.09	1,272.89	0.20
4.00	576.60	811.10	861.58	0.06	988.67	0.22
5.00	615.96	740.45	719.07	-0.03	844.09	0.14
6.00	547.51	725.48	696.08	-0.04	820.44	0.13
7.00	521.85	705.88	668.31	-0.05	791.75	0.12
8.00	696.38	703.98	611.01	-0.13	732.08	0.04
STANDARD ERROR				0.128		0.202

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	8,836.98	7,544.88
EXPONENT	-0.40	-0.35
SLOPE	75.67	78.39
R SQR	1.00	0.99
STD ERR EST	0.14	0.26

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	3.00	0.86	19,404.00	17,040.83	-0.12	15,452.80	-0.20
4.00	79.00	29.55	74,121.00	103,341.10	0.39	113,203.40	0.53
80.00	159.00	115.85	74,600.00	62,483.65	-0.16	73,733.53	-0.01
160.00	326.00	235.76	96,293.00	98,010.29	0.02	119,918.20	0.25
327.00	511.00	413.79	113,953.00	86,569.01	-0.24	109,020.20	-0.04
512.00	554.00	532.31	23,543.00	18,180.63	-0.23	23,193.99	-0.01
555.00	613.00	583.16	30,789.00	24,046.21	-0.22	30,820.36	0.00
614.00	766.00	687.56	106,546.00	58,361.78	-0.45	75,430.95	-0.29
STANDARD ERROR					0.264		0.242

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	3.64	4.32	
CURVE FIT WITH THE CALOT TECHNIQUE	1.98	4.32	

H-37 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	12,793.00	12,793.00	12,748.00	-0.00	13,529.75	0.06
2.00	5,146.68	6,189.36	6,461.24	0.04	6,632.48	0.07
3.00	4,725.78	5,764.45	5,748.01	-0.00	5,867.59	0.02
4.00	4,349.47	5,303.04	4,951.72	-0.07	4,864.29	-0.08
5.00	2,734.17	4,092.43	4,011.43	-0.02	3,943.85	-0.04
6.00	2,181.52	3,720.86	3,731.81	0.00	3,666.89	-0.01
7.00	2,128.50	3,472.05	3,525.13	0.02	3,461.44	-0.00
STANDARD ERROR				0.032		0.049

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	18,542.69	19,671.79
EXPONENT	-0.34	-0.36
SLOPE	78.95	78.14
R SQR	1.00	0.99
STD ERR EST	0.03	0.15

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	3.00	0.86	38,379.00	38,244.01	-0.00	40,589.25	0.06
4.00	22.00	10.51	97,787.00	103,903.20	0.06	105,325.40	0.08
23.00	31.00	26.32	42,532.00	36,041.02	-0.15	35,980.77	-0.15
34.00	48.00	40.18	65,242.00	52,000.00	-0.20	51,590.56	-0.21
49.00	89.00	67.06	112,101.00	119,334.60	0.06	117,516.50	0.05
90.00	110.00	99.24	45,812.00	53,482.41	0.17	52,355.05	0.14
111.00	130.00	119.81	42,570.00	47,767.25	0.12	46,630.13	0.10
STANDARD ERROR					0.128		0.125

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	5.16	5.46	
CURVE FIT WITH THE CALOT TECHNIQUE	3.84	5.46	

H-53 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	6.75	6.75	6.72	-0.00	6.71	-0.01
2.00	4.26	4.44	4.53	0.02	4.52	0.02
3.00	3.76	4.10	4.08	-0.00	4.07	-0.01
4.00	3.38	4.07	4.06	-0.00	4.05	-0.01
5.00	3.34	4.00	4.00	-0.00	3.99	-0.00
6.00	3.15	3.98	3.99	0.00	3.98	-0.00
7.00	3.69	3.96	3.93	-0.01	3.92	-0.01
STANDARD ERROR				0.008		0.009

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	9.48	9.47
EXPONENT	-0.15	-0.15
SLOPE	90.17	90.15
R SQR	1.00	0.99
STD ERR EST	0.01	0.06

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	10.00	3.38	67.52	67.21	-0.00	67.14	-0.01
11.00	141.00	61.40	558.58	571.16	0.02	569.83	0.02
142.00	281.00	206.42	526.68	509.37	-0.03	507.92	-0.04
282.00	293.00	286.98	40.58	41.56	0.02	41.44	0.02
294.00	323.00	307.85	100.23	102.83	0.03	102.52	0.02
324.00	331.00	327.00	25.23	27.18	0.08	27.09	0.07
332.00	361.00	345.87	110.55	101.05	-0.09	100.75	-0.09
STANDARD ERROR					0.048		0.048

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.45	5.46	
CURVE FIT WITH THE CALOT TECHNIQUE	0.53	5.46	

HH-52 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	1,327.75	1,327.75	1,314.54	-0.01	1,277.97	-0.04
2.00	929.07	1,188.67	1,199.86	0.01	1,180.07	-0.01
3.00	913.65	1,110.75	1,117.75	0.01	1,109.32	-0.00
4.00	852.07	1,059.01	1,065.92	0.01	1,064.34	0.01
5.00	876.00	1,033.77	1,032.79	-0.00	1,035.45	0.00
6.00	888.00	1,016.10	1,004.78	-0.01	1,010.94	-0.01
STANDARD ERROR				0.008		0.016

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	2,671.15	2,365.00
EXPONENT	-0.21	-0.19
SLOPE	86.29	87.96
R SQR	1.00	0.98
STD ERR EST	0.01	0.06

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	28.00	9.22	37,177.00	36,807.16	-0.01	35,783.12	-0.04
29.00	43.00	35.18	13,936.00	14,786.92	0.06	14,960.05	0.07
44.00	60.00	51.22	15,532.00	15,471.10	-0.00	15,816.05	0.02
61.00	75.00	67.33	12,781.00	12,879.02	0.01	13,266.38	0.04
76.00	87.00	80.91	10,512.00	9,908.18	-0.06	10,258.29	-0.02
88.00	99.00	92.92	10,656.00	9,620.60	-0.10	9,998.78	-0.06
STANDARD ERROR					0.053		0.046

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	4.52	9.00	
CURVE FIT WITH THE CALOT TECHNIQUE	4.00	9.00	

HH-54 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	5.25	5.25	5.18	-0.01	5.00	-0.05
2.00	3.39	3.76	3.85	0.02	3.93	0.04
3.00	2.80	3.28	3.38	0.03	3.54	0.08
4.00	3.40	3.31	3.18	-0.04	3.37	0.02
STANDARD ERROR				0.028		0.052

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	7.23	6.54
EXPONENT	-0.19	-0.15
SLOPE	87.93	90.13
R SQR	0.99	0.90
STD ERR EST	0.04	0.15

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	6.00	2.03	31.49	31.10	-0.01	30.01	-0.05
7.00	30.00	16.26	81.31	84.26	0.04	87.86	0.08
31.00	60.00	44.01	84.03	87.51	0.04	94.60	0.13
61.00	83.00	71.14	78.25	61.37	-0.22	67.49	-0.14
STANDARD ERROR					0.112		0.104

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

J-33 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.41	0.41	0.40	-0.03	0.39	-0.06
2.00	0.15	0.24	0.25	0.05	0.26	0.08
3.00	0.15	0.22	0.23	0.02	0.24	0.07
4.00	0.17	0.22	0.22	0.00	0.23	0.05
5.00	0.13	0.19	0.18	-0.04	0.19	0.03
STANDARD ERROR				0.033		0.061

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	6.69	4.14
EXPONENT	-0.43	-0.36
SLOPE	74.44	77.87
R SQR	1.00	0.97
STD ERR EST	0.04	0.17

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	730.00	204.30	302.50	294.67	-0.03	283.26	-0.06
731.00	2,287.00	1,407.96	239.60	272.9[illegible]	0.14	301.01	0.26
2,288.00	2,825.00	2,549.40	83.20	73.20	-0.12	83.95	0.01
2,826.00	3,160.00	2,990.34	58.00	42.58	-0.27	49.35	-0.15
3,161.00	5,044.00	4,050.99	251.20	210.46	-0.16	248.73	-0.01
STANDARD ERROR					0.162		0.136

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	36.83	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	1.88	49.50	

J-35 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.53	0.53	0.57	0.07	0.58	0.09
2.00	0.44	0.45	0.40	-0.11	0.38	-0.14
3.00	0.31	0.40	0.37	-0.06	0.35	-0.11
4.00	0.26	0.33	0.34	0.02	0.32	-0.05
5.00	0.26	0.31	0.32	0.04	0.29	-0.04
6.00	0.22	0.29	0.31	0.06	0.28	-0.02
STANDARD ERROR				0.066		0.087

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	1.04	1.19
EXPONENT	-0.15	-0.17
SLOPE	90.41	88.81
R SQR	0.98	0.98
STD ERR EST	0.08	0.12

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	65.00	21.66	34.60	36.86	0.07	37.74	0.09
66.00	759.00	339.64	303.70	264.12	-0.13	251.56	-0.17
760.00	1,200.00	969.66	136.80	144.19	0.05	133.58	-0.02
1,201.00	2,273.00	1,703.29	277.80	323.20	0.16	295.13	0.06
2,274.00	3,495.00	2,858.43	317.00	341.38	0.08	307.60	-0.03
3,496.00	4,282.00	3,880.71	171.00	210.30	0.23	188.00	0.10
STANDARD ERROR					0.135		0.094

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	7.93	9.00	
CURVE FIT WITH THE CALOT TECHNIQUE	0.79	9.00	

J-57 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.96	0.96	0.99	0.03	1.01	0.04
2.00	0.85	0.86	0.83	-0.03	0.83	-0.04
3.00	0.74	0.78	0.76	-0.02	0.75	-0.04
4.00	0.67	0.72	0.72	-0.00	0.70	-0.03
5.00	0.58	0.66	0.69	0.04	0.67	0.01
STANDARD ERROR				0.027		0.034

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	1.45	1.56
EXPONENT	-0.08	-0.09
SLOPE	94.40	93.67
R SQR	0.99	0.98
STD ERR EST	0.04	0.06

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	103.00	36.01	99.20	101.74	0.03	103.52	0.04
104.00	783.00	386.36	576.80	551.57	-0.04	546.43	-0.05
784.00	2,247.00	1,446.65	1,082.10	1,064.08	-0.02	1,038.74	-0.04
2,248.00	4,713.00	3,397.83	1,642.00	1,669.48	0.02	1,614.34	-0.02
4,714.00	7,752.00	6,164.01	1,754.80	1,957.97	0.12	1,880.81	0.07
STANDARD ERROR					0.057		0.048

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	10.24	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	4.68	49.50	

J-60 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.25	0.25	0.25	-0.00	0.25	-0.01
2.00	0.24	0.24	0.24	0.00	0.24	0.01
3.00	0.23	0.24	0.24	0.01	0.24	0.02
4.00	0.25	0.24	0.24	-0.01	0.24	0.00
5.00	0.24	0.24	0.24	-0.01	0.24	0.00
STANDARD ERROR				0.007		0.010

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	0.26	0.25
EXPONENT	-0.01	-0.01
SLOPE	99.16	99.37
R SQR	0.95	0.78
STD ERR EST	0.01	0.03

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	14.00	5.13	3.50	3.49	-0.00	3.48	-0.01
15.00	221.00	97.79	49.60	49.81	0.00	50.05	0.01
222.00	440.00	324.24	50.80	51.93	0.02	52.38	0.03
441.00	647.00	540.08	51.20	48.78	-0.05	49.28	-0.04
648.00	691.00	669.21	10.40	10.34	-0.01	10.45	0.01
STANDARD ERROR					0.024		0.022

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	27.43	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	0.28	49.50	

J-69 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.07	0.07	0.07	0.01	0.07	0.00
2.00	0.07	0.07	0.07	-0.02	0.07	-0.02
3.00	0.06	0.07	0.07	0.00	0.07	0.02
4.00	0.06	0.07	0.07	0.00	0.07	0.03
5.00	0.06	0.06	0.06	0.02	0.07	0.06
6.00	0.06	0.06	0.06	0.00	0.07	0.04
7.00	0.07	0.06	0.06	-0.02	0.06	0.02
STANDARD ERROR				0.014		0.032

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	0.12	0.10
EXPONENT	-0.08	-0.06
SLOPE	94.46	96.23
R SQR	0.99	0.85
STD ERR EST	0.02	0.11

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	401.00	143.29	28.60	28.89	0.01	28.70	0.00
402.00	504.00	451.47	7.70	6.74	-0.12	6.92	-0.10
505.00	1,056.00	762.31	33.80	34.61	0.02	36.01	0.07
1,057.00	1,299.00	1,175.33	14.50	14.70	0.01	15.48	0.07
1,300.00	1,768.00	1,527.05	25.80	27.77	0.08	29.44	0.14
1,769.00	2,150.00	1,955.90	24.00	22.17	-0.08	23.65	-0.01
2,151.00	2,434.00	2,290.53	20.10	16.27	-0.19	17.43	-0.13
STANDARD ERROR					0.096		0.090

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.42	5.46	
CURVE FIT WITH THE CALOT TECHNIQUE	1.39	5.46	

J-71 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	1.55	1.55	1.59	0.03	1.47	-0.05
2.00	1.32	1.41	1.32	-0.06	1.30	-0.08
3.00	0.81	0.95	1.00	0.05	1.07	0.13
4.00	0.63	0.72	0.77	0.08	0.90	0.26
5.00	1.08	0.80	0.73	-0.08	0.87	0.09
STANDARD ERROR				0.064		0.141

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	2.91	2.22
EXPONENT	-0.20	-0.13
SLOPE	87.20	91.11
R SQR	0.99	0.84
STD ERR EST	0.08	0.30

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	21.00	7.17	32.60	33.47	0.03	30.93	-0.05
22.00	54.00	36.06	43.70	37.95	-0.13	39.13	-0.10
55.00	226.00	128.94	138.70	153.86	0.11	171.88	0.24
227.00	816.00	486.64	368.80	405.89	0.10	493.28	0.34
817.00	1,062.00	935.93	265.30	148.61	-0.44	188.38	-0.29
STANDARD ERROR					0.216		0.232

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.39	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	0.51	49.50	

J-75 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	1.32	1.32	1.32	0.00	1.31	-0.01
2.00	1.11	1.14	1.12	-0.02	1.12	-0.02
3.00	0.93	1.04	1.05	0.01	1.06	0.02
4.00	0.94	1.01	1.02	0.01	1.03	0.02
5.00	0.91	0.99	1.00	0.01	1.01	0.02
6.00	0.93	0.98	0.98	-0.00	0.99	0.01
7.00	0.94	0.98	0.97	-0.01	0.98	0.00
STANDARD ERROR				0.010		0.014

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	1.92	1.84
EXPONENT	-0.09	-0.09
SLOPE	93.67	94.17
R SQR	1.00	0.99
STD ERR EST	0.01	0.04

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	53.00	18.61	69.80	70.12	0.00	69.24	-0.01
54.00	311.00	162.94	285.50	278.09	-0.03	279.27	-0.02
312.00	605.00	449.24	273.40	287.97	0.05	291.44	0.07
606.00	861.00	728.94	240.50	239.55	-0.00	243.34	0.01
862.00	1,065.00	961.01	186.20	185.98	-0.00	189.32	0.02
1,066.00	1,284.00	1,172.68	204.00	195.94	-0.04	199.76	-0.02
1,285.00	1,462.00	1,371.98	166.90	156.92	-0.06	160.17	-0.04
STANDARD ERROR					0.035		0.032

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.39	5.46	
CURVE FIT WITH THE CALOT TECHNIQUE	2.02	5.46	

J-79 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	1.69	1.69	1.73	0.03	1.81	0.07
2.00	1.34	1.48	1.45	-0.02	1.46	-0.01
3.00	1.20	1.40	1.36	-0.03	1.35	-0.04
4.00	1.06	1.35	1.32	-0.03	1.30	-0.04
5.00	0.75	1.16	1.22	0.05	1.18	0.02
STANDARD ERROR				0.033		0.042

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	5.50	7.28
EXPONENT	-0.20	-0.24
SLOPE	87.00	84.51
R SQR	0.98	0.93
STD ERR EST	0.04	0.16

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	316.00	99.19	532.70	546.59	0.03	570.61	0.07
317.00	749.00	513.22	578.30	542.78	-0.06	524.61	-0.09
750.00	1,055.00	896.51	366.10	343.03	-0.06	323.78	-0.12
1,056.00	1,222.00	1,137.18	177.60	178.48	0.00	166.79	-0.06
1,223.00	1,826.00	1,511.30	454.40	609.65	0.34	563.00	0.24
STANDARD ERROR					0.158		0.133

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	12.62	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	6.32	49.50	

J-85 'S CUMULATIVE AVERAGE LEARNING CURVE

SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.67	0.67	0.67	0.00	0.68	0.02
2.00	0.45	0.49	0.49	-0.00	0.48	-0.01
3.00	0.38	0.45	0.44	-0.01	0.44	-0.02
4.00	0.34	0.42	0.42	-0.00	0.41	-0.02
5.00	0.30	0.39	0.40	0.02	0.39	-0.01
STANDARD ERROR				0.009		0.018

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	1.69	1.63
EXPONENT	-0.19	-0.20
SLOPE	87.80	87.01
R SQR	1.00	0.99
STD ERR EST	0.01	0.05

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	135.00	44.01	90.40	90.80	0.00	92.19	0.02
136.00	761.00	397.32	281.20	279.12	-0.01	274.89	-0.02
762.00	1,246.00	991.53	186.70	182.20	-0.02	177.27	-0.05
1,247.00	1,694.00	1,463.11	153.30	156.44	0.02	151.45	-0.01
1,695.00	2,205.00	1,942.72	152.60	169.19	0.11	163.19	0.07
STANDARD ERROR					0.051		0.041

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	5.16	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	0.84	49.50	

OH-58 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	135.20	135.20	134.67	-0.00	135.40	0.00
2.00	114.63	118.75	121.07	0.02	121.18	0.02
3.00	112.93	115.42	114.46	-0.01	114.30	-0.01
4.00	107.79	112.24	110.45	-0.02	110.13	-0.02
5.00	99.24	107.91	107.53	-0.00	107.10	-0.01
6.00	97.53	105.31	105.50	0.00	104.99	-0.00
7.00	95.81	103.41	103.95	0.01	103.39	-0.00
8.00	95.81	102.15	102.71	0.01	102.10	-0.00
STANDARD ERROR				0.010		0.011

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	161.11	163.20
EXPONENT	-0.07	-0.07
SLOPE	95.52	95.55
R SQR	1.00	0.99
STD ERR EST	0.01	0.02

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	15.00	5.32	2,028.00	2,020.11	-0.00	2,031.05	0.00
16.00	75.00	40.98	6,878.00	7,059.90	0.03	7,057.42	0.03
76.00	175.00	121.30	11,293.00	10,951.34	-0.03	10,914.46	-0.03
176.00	300.00	234.52	13,474.00	13,104.76	-0.03	13,056.75	-0.03
301.00	450.00	372.31	14,886.00	15,252.04	0.02	15,153.43	0.02
451.00	600.00	523.08	14,629.00	14,912.67	0.02	14,802.29	0.01
601.00	750.00	673.50	14,372.00	14,665.29	0.02	14,546.55	0.01
751.00	900.00	823.86	14,372.00	14,471.09	0.01	14,345.33	-0.00
STANDARD ERROR					0.022		0.021

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.59	4.32	
CURVE FIT WITH THE CALOT TECHNIQUE	2.43	4.32	

P-3C 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	9.75	9.75	9.70	-0.01	9.78	0.00
2.00	8.04	8.92	8.81	-0.01	8.79	-0.01
3.00	6.54	8.11	8.30	0.02	8.23	0.01
4.00	6.42	7.87	8.12	0.03	8.03	0.02
5.00	8.67	8.05	7.83	-0.03	7.71	-0.04
6.00	5.53	7.79	7.71	-0.01	7.59	-0.03
STANDARD ERROR				0.021		0.023

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	15.27	16.18
EXPONENT	-0.14	-0.16
SLOPE	90.57	89.59
R SQR	0.98	0.88
STD ERR EST	0.03	0.16

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	24.00	8.05	234.10	232.73	-0.01	234.77	0.00
25.00	47.00	34.76	185.00	181.30	-0.02	178.41	-0.04
48.00	71.00	58.52	156.90	175.62	0.12	171.41	0.09
72.00	83.00	76.91	77.00	84.45	0.10	82.07	0.07
84.00	107.00	94.71	208.00	163.95	-0.21	158.81	-0.24
108.00	119.00	112.94	66.40	79.94	0.20	77.22	0.16
STANDARD ERROR					0.136		0.127

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	1.77	9.00	
CURVE FIT WITH THE CALOT TECHNIQUE	0.06	9.00	

S-3A 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	14.59	14.59	14.52	-0.01	14.34	-0.02
2.00	8.33	10.03	10.11	0.01	10.13	0.01
3.00	6.52	8.33	8.41	0.01	8.50	0.02
4.00	6.19	7.63	7.54	-0.01	7.66	0.00
STANDARD ERROR				0.009		0.014

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	29.57	28.21
EXPONENT	-0.28	-0.26
SLOPE	82.51	83.23
R SQR	1.00	1.00
STD ERR EST	0.01	0.05

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	13.00	4.02	189.70	188.74	-0.01	186.48	-0.02
14.00	48.00	28.16	291.70	296.39	0.02	299.95	0.03
49.00	93.00	68.93	293.50	297.31	0.01	304.26	0.04
94.00	138.00	114.56	278.70	258.25	-0.07	265.97	-0.05
STANDARD ERROR					0.038		0.034

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

SH-3 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	12,408.56	12,408.56	11,050.50	-0.11	8,820.65	-0.29
2.00	2,800.90	5,782.59	6,288.04	0.09	5,554.42	-0.04
3.00	2,087.43	3,461.27	3,903.51	0.13	3,760.72	0.09
4.00	1,952.25	2,742.21	2,857.62	0.04	2,914.75	0.06
5.00	1,524.51	2,459.75	2,516.37	0.02	2,627.20	0.07
6.00	1,574.11	2,321.13	2,318.20	-0.00	2,457.00	0.06
7.00	1,338.00	2,188.08	2,161.32	-0.01	2,320.38	0.06
8.00	1,433.83	2,111.63	2,052.84	-0.03	2,224.86	0.05
9.00	1,459.50	2,062.72	1,977.15	-0.04	2,157.67	0.05
10.00	1,789.71	2,043.67	1,909.44	-0.07	2,097.15	0.03
STANDARD ERROR				0.067		0.107

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	31,857.13	20,789.27
EXPONENT	-0.48	-0.39
SLOPE	71.60	76.16
R SQR	1.00	0.99
STD ERR EST	0.07	0.24

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	9.00	2.49	111,677.00	99,454.49	-0.11	79,385.83	-0.29
10.00	29.00	17.67	56,018.00	82,898.55	0.48	81,692.20	0.46
30.00	78.00	50.72	102,284.00	122,120.80	0.19	132,258.00	0.29
79.00	149.00	110.83	138,610.00	121,311.60	-0.12	140,961.40	0.02
150.00	194.00	170.80	68,603.00	62,390.15	-0.09	75,379.66	0.10
195.00	230.00	211.64	56,668.00	45,010.85	-0.21	55,433.08	-0.02
231.00	266.00	247.69	48,168.00	41,724.68	-0.13	52,111.13	0.08
267.00	296.00	280.82	43,015.00	32,729.86	-0.24	41,336.59	-0.04
297.00	320.00	307.89	35,028.00	25,047.28	-0.28	31,894.99	-0.09
321.00	344.00	331.90	42,953.00	24,157.35	-0.44	30,967.56	-0.28
STANDARD ERROR					0.263		0.220

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	3.10	3.46	
CURVE FIT WITH THE CALOT TECHNIQUE	2.11	3.46	

T-38 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	18.45	18.45	18.50	0.00	18.07	-0.02
2.00	6.88	10.73	11.57	0.08	11.39	0.06
3.00	6.45	7.81	7.07	-0.09	7.03	-0.10
4.00	2.84	4.21	4.08	-0.03	4.10	-0.03
5.00	1.54	2.41	2.52	0.05	2.56	0.06
6.00	1.37	1.99	2.02	0.02	2.06	0.04
7.00	1.20	1.77	1.76	-0.01	1.80	0.02
STANDARD ERROR				0.051		0.054

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	24.87	23.99
EXPONENT	-0.43	-0.42
SLOPE	74.37	74.87
R SQR	1.00	1.00
STD ERR EST	0.06	0.16

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	2.00	0.54	36.90	36.99	0.00	36.15	-0.02
3.00	6.00	3.74	27.50	32.42	0.18	32.21	0.17
7.00	19.00	11.63	83.90	64.92	-0.23	65.21	-0.22
20.00	69.00	40.29	142.20	146.86	0.03	149.30	0.05
70.00	213.00	131.57	222.20	255.12	0.15	262.31	0.18
214.00	357.00	280.59	196.90	184.62	-0.06	191.20	-0.03
358.00	494.00	422.85	164.50	147.42	-0.10	153.28	-0.07
STANDARD ERROR					0.131		0.131

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.75	5.46	
CURVE FIT WITH THE CALOT TECHNIQUE	0.56	5.46	

T-39 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	2.84	2.84	2.81	-0.01	2.70	-0.05
2.00	1.58	2.38	2.47	0.04	2.54	0.07
3.00	3.19	2.43	2.43	-0.00	2.52	0.04
4.00	2.04	2.36	2.31	-0.02	2.46	0.04
STANDARD ERROR				0.024		0.051

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	9.88	4.86
EXPONENT	-0.28	-0.13
SLOPE	82.52	91.41
R SQR	0.95	0.55
STD ERR EST	0.03	0.37

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	94.00	32.13	267.30	263.75	-0.01	253.52	-0.05
95.00	149.00	120.31	86.70	104.21	0.20	125.01	0.44
150.00	159.00	153.98	31.90	17.69	-0.45	22.01	-0.31
160.00	191.00	174.72	65.40	54.66	-0.16	69.30	0.06
STANDARD ERROR					0.258		0.273

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

TF-30 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	2.27	2.27	2.28	0.00	2.31	0.02
2.00	2.17	2.19	2.21	0.01	2.21	0.01
3.00	2.21	2.20	2.16	-0.02	2.13	-0.03
4.00	2.09	2.14	2.13	-0.01	2.09	-0.03
5.00	1.90	2.07	2.11	0.02	2.06	-0.00
STANDARD ERROR				0.014		0.021

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	2.45	2.58
EXPONENT	-0.02	-0.03
SLOPE	98.59	97.92
R SQR	0.93	0.88
STD ERR EST	0.02	0.05

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	39.00	14.13	88.60	88.80	0.00	90.03	0.02
40.00	172.00	97.53	288.30	291.11	0.01	289.56	0.00
173.00	536.00	336.87	804.20	776.79	-0.03	763.23	-0.05
537.00	1,120.00	809.79	1,219.70	1,224.13	0.00	1,192.39	-0.02
1,121.00	1,613.00	1,358.84	938.30	1,022.51	0.09	990.91	0.06
STANDARD ERROR					0.043		0.036

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	3.12	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	3.03	49.50	

TF-33 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.80	0.80	0.81	0.01	0.80	0.00
2.00	0.81	0.81	0.78	-0.03	0.79	-0.02
3.00	0.75	0.76	0.78	0.02	0.79	0.03
4.00	0.81	0.77	0.77	0.00	0.79	0.02
STANDARD ERROR				0.018		0.021

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	0.81	0.80
EXPONENT	-0.01	-0.00
SLOPE	99.56	99.78
R SQR	0.72	0.54
STD ERR EST	0.03	0.04

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	2.00	0.73	1.60	1.61	0.01	1.60	0.00
3.00	168.00	65.12	134.00	130.12	-0.03	131.32	-0.02
169.00	852.00	466.93	513.10	529.56	0.03	537.78	0.05
853.00	1,146.00	995.09	237.50	226.54	-0.05	230.61	-0.03
STANDARD ERROR					0.032		0.030

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

TF-34 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	1.60	1.60	1.58	-0.01	1.57	-0.02
2.00	1.07	1.14	1.17	0.03	1.19	0.05
3.00	1.02	1.09	1.08	-0.01	1.10	0.01
4.00	0.93	1.03	1.02	-0.02	1.04	0.01
STANDARD ERROR				0.019		0.025

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	2.27	2.20
EXPONENT	-0.14	-0.13
SLOPE	90.74	91.34
R SQR	0.99	0.99
STD ERR EST	0.03	0.05

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	13.00	4.45	20.80	20.60	-0.01	20.44	-0.02
14.00	111.00	53.15	105.30	109.64	0.04	111.42	0.06
112.00	204.00	154.85	95.30	89.55	-0.06	91.95	-0.04
205.00	309.00	254.45	97.60	94.30	-0.03	97.29	-0.00
STANDARD ERROR					0.041		0.035

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

TF-39 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	4.81	4.81	4.83	0.00	4.90	0.02
2.00	3.30	3.83	3.81	-0.01	3.79	-0.01
3.00	2.71	3.29	3.27	-0.00	3.23	-0.02
4.00	2.28	3.13	3.15	0.01	3.09	-0.01
STANDARD ERROR				0.005		0.015

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	12.29	13.26
EXPONENT	-0.23	-0.24
SLOPE	85.48	84.55
R SQR	1.00	0.99
STD ERR EST	0.01	0.05

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	62.00	19.53	298.40	299.36	0.00	303.55	0.02
63.00	177.00	113.35	379.90	374.57	-0.01	367.82	-0.03
178.00	345.00	255.20	455.10	455.43	0.00	441.49	-0.03
346.00	410.00	376.92	148.50	161.33	0.09	155.42	0.05
STANDARD ERROR					0.044		0.033

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

UH-1N 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	797.33	797.33	794.72	-0.00	782.73	-0.02
2.00	742.58	776.11	778.52	0.00	776.46	0.00
3.00	723.75	756.54	763.36	0.01	770.52	0.02
4.00	805.88	761.69	759.83	-0.00	769.13	0.01
5.00	756.26	761.12	756.30	-0.01	767.73	0.01
STANDARD ERROR				0.005		0.013

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	954.84	840.90
EXPONENT	-0.04	-0.02
SLOPE	97.13	98.87
R SQR	0.97	0.70
STD ERR EST	0.01	0.05

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	79.00	28.82	62,989.00	62,782.76	-0.00	61,835.81	-0.02
80.00	129.00	102.97	37,129.00	37,645.67	0.01	38,327.56	0.03
130.00	206.00	165.99	55,729.00	56,823.04	0.02	58,563.91	0.05
207.00	230.00	217.86	19,341.00	17,509.67	-0.09	18,172.44	-0.06
231.00	257.00	243.38	20,419.00	19,606.96	-0.04	20,406.88	-0.00
STANDARD ERROR					0.047		0.039

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	7.24	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	0.55	49.50	

UH-60 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	15,855.33	15,855.33	15,453.77	-0.03	14,917.69	-0.06
2.00	5,454.73	7,188.17	7,404.45	0.03	7,388.33	0.03
3.00	2,919.14	3,957.55	4,143.58	0.05	4,253.29	0.07
4.00	2,456.93	3,125.89	2,973.66	-0.05	3,103.09	-0.01
STANDARD ERROR				0.039		0.050

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	24,263.88	22,694.76
EXPONENT	-0.41	-0.39
SLOPE	75.23	76.34
R SQR	1.00	0.99
STD ERR EST	0.06	0.13

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	3.00	0.83	47,566.00	46,361.30	-0.03	44,753.08	-0.06
4.00	18.00	9.02	81,821.00	86,918.81	0.06	88,236.86	0.08
19.00	74.00	41.54	163,472.00	173,344.60	0.06	181,753.20	0.11
75.00	166.00	115.69	226,038.00	187,002.60	-0.17	200,369.40	-0.11
STANDARD ERROR					0.097		0.094

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

Appendix C: System Minus Last Lot Runs

Appendix C provides the computer outputs for predicting the last lot costs for the system minus last lot runs. The last lot costs have been predicted with the ET and Calot techniques.

A-3D 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	25.40	25.40	26.75	0.05	27.68	0.09
2.00	16.74	17.98	15.81	-0.12	15.40	-0.14
3.00	7.42	10.27	11.09	0.08	10.39	0.01
STANDARD ERROR				0.089		0.098

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	32.27	33.94
EXPONENT	-0.27	-0.30
SLOPE	82.91	81.23
R SQR	0.94	0.90
STD ERR EST	0.16	0.28

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	2.00	0.60	50.80	53.50	0.05	55.36	0.09
3.00	14.00	6.82	200.90	167.79	-0.16	160.31	-0.20
15.00	52.00	30.37	282.10	355.16	0.26	324.42	0.15
STANDARD ERROR					0.180		0.154

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.50	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.50	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT 53 127

PREDICTION WITH ELEMENTARY TECHNIQUE 529.44

PREDICTION WITH CALOT TECHNIQUE 468.73

A-4 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	12.60	12.60	12.92	0.03	13.74	0.09
2.00	8.14	8.59	7.70	-0.10	6.89	-0.20
3.00	3.53	6.06	6.59	0.09	5.60	-0.08
STANDARD ERROR				0.080		0.133

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	12.92	13.69
EXPONENT	-0.22	-0.30
SLOPE	85.57	81.29
R SQR	0.93	0.85
STD ERR EST	0.14	0.36

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	1.00	0.30	12.60	12.92	0.03	13.74	0.09
2.00	10.00	4.49	73.30	64.09	-0.13	55.13	-0.25
11.00	20.00	14.62	35.30	54.79	0.55	43.04	0.22
STANDARD ERROR					0.327		0.198

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC F-TABLE (90%)
%-1,525,690,000.00 2.81

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC F-TABLE (90%)
0.49 2.81

FIRST UNIT, LAST UNIT FOR PREDICT 21 72

PREDICTION WITH ELEMENTARY TECHNIQUE 224.00

PREDICTION WITH CALOT TECHNIQUE 162.66

A-5 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	18.34	18.34	18.25	-0.00	17.04	-0.07
2.00	13.49	15.62	15.62	-0.00	15.55	-0.00
3.00	10.31	12.04	12.62	0.05	13.71	0.14
4.00	14.79	12.61	12.08	-0.04	13.36	0.06
STANDARD ERROR				0.032		0.083

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	28.74	22.29
EXPONENT	-0.19	-0.11
SLOPE	87.70	92.54
R SQR	0.98	0.71
STD ERR EST	0.05	0.22

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	11.00	3.81	201.70	200.72	-0.00	187.49	-0.07
12.00	25.00	17.48	188.90	189.78	0.00	201.21	0.07
26.00	77.00	48.38	536.30	581.46	0.08	666.88	0.24
78.00	97.00	86.79	295.80	200.07	-0.32	240.26	-0.19
STANDARD ERROR					0.167		0.161

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT 98 120

PREDICTION WITH ELEMENTARY TECHNIQUE 220.64

PREDICTION WITH CALOT TECHNIQUE 269.55

A-6 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	15.99	15.99	16.20	0.01	16.37	0.02
2.00	10.18	12.51	12.43	-0.01	12.50	-0.00
3.00	7.87	10.02	9.97	-0.01	9.98	-0.00
4.00	6.73	8.50	8.33	-0.02	8.32	-0.02
5.00	5.33	7.31	7.27	-0.00	7.25	-0.01
6.00	4.43	6.35	6.47	0.02	6.44	0.01
7.00	4.43	5.64	5.66	0.00	5.63	-0.00
STANDARD ERROR				0.012		0.014

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	29.55	30.02
EXPONENT	-0.29	-0.29
SLOPE	81.85	81.62
R SQR	1.00	1.00
STD ERR EST	0.01	0.05

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	8.00	2.43	127.90	129.62	0.01	130.95	0.02
9.00	20.00	13.41	122.20	119.06	-0.03	119.05	-0.03
21.00	43.00	30.56	180.90	179.91	-0.01	179.28	-0.01
44.00	80.00	60.26	248.90	237.86	-0.04	236.37	-0.05
81.00	128.00	102.78	255.60	264.48	0.03	262.25	0.03
129.00	192.00	158.60	283.50	311.11	0.10	307.93	0.09
193.00	304.00	245.22	496.20	480.04	-0.03	474.29	-0.04
STANDARD ERROR					0.046		0.045

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	2.45	5.46	
CURVE FIT WITH THE CALOT TECHNIQUE	0.16	5.46	

FIRST UNIT, LAST UNIT FOR PREDICT	305	367
PREDICTION WITH ELEMENTARY TECHNIQUE	246.78	
PREDICTION WITH CALOT TECHNIQUE	243.51	

A-7A 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	9.43	9.43	9.44	0.00	9.44	0.00
2.00	5.38	7.11	7.02	-0.01	7.03	-0.01
3.00	2.95	3.65	3.75	0.03	3.77	0.03
4.00	1.82	2.21	2.18	-0.01	2.20	-0.00
STANDARD ERROR				0.017		0.018

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	13.86	13.76
EXPONENT	-0.35	-0.35
SLOPE	78.46	78.63
R SQR	1.00	1.00
STD ERR EST	0.02	0.05

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	3.00	0.87	28.30	28.32	0.00	28.33	0.00
4.00	7.00	4.81	21.50	20.80	-0.03	20.86	-0.03
8.00	42.00	21.19	103.30	108.32	0.05	109.16	0.06
43.00	199.00	107.38	286.20	275.39	-0.04	278.90	-0.03
STANDARD ERROR					0.035		0.034

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	200	395
PREDICTION WITH ELEMENTARY TECHNIQUE	243.06	
PREDICTION WITH CALOT TECHNIQUE	246.84	

A-10A 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	9.95	9.95	10.01	0.01	10.10	0.02
2.00	5.75	6.65	6.52	-0.02	6.47	-0.03
3.00	3.97	5.26	5.33	0.01	5.25	-0.00
STANDARD ERROR				0.013		0.018

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	16.46	16.83
EXPONENT	-0.28	-0.29
SLOPE	82.49	81.94
R SQR	1.00	0.99
STD ERR EST	0.02	0.06

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	6.00	1.82	59.70	60.05	0.01	60.61	0.02
7.00	28.00	15.25	126.40	122.65	-0.03	120.59	-0.05
29.00	58.00	41.83	119.20	126.45	0.06	123.06	0.03
STANDARD ERROR					0.039		0.034

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.50 F-TABLE 2.81 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.50 F-TABLE 2.81 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 59 101

PREDICTION WITH ELEMENTARY TECHNIQUE 152.33

PREDICTION WITH CALOT TECHNIQUE 147.35

AH-1G 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.98	0.98	0.98	-0.00	0.97	-0.01
2.00	0.60	0.68	0.68	0.01	0.69	0.03
3.00	0.54	0.62	0.62	-0.01	0.63	0.01
STANDARD ERROR				0.010		0.018

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	2.83	2.61
EXPONENT	-0.23	-0.21
SLOPE	85.48	86.37
R SQR	1.00	0.99
STD ERR EST	0.02	0.05

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	110.00	35.53	107.84	107.50	-0.00	106.49	-0.01
111.00	530.00	288.34	250.08	255.40	0.02	261.19	0.04
531.00	838.00	676.86	164.95	154.39	-0.06	159.93	-0.03
STANDARD ERROR					0.039		0.032

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.10	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	-3.32	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	839	876
PREDICTION WITH ELEMENTARY TECHNIQUE	18.06	
PREDICTION WITH CALOT TECHNIQUE	18.77	

AIM-7F (GD) 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	1.55	1.55	1.45	-0.06	1.37	-0.12
2.00	0.38	0.59	0.64	0.08	0.63	0.07
3.00	0.23	0.33	0.35	0.06	0.36	0.08
4.00	0.19	0.27	0.27	-0.01	0.28	0.02
5.00	0.13	0.19	0.18	-0.06	0.19	-0.01
STANDARD ERROR				0.062		0.071

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	5.27	4.55
EXPONENT	-0.48	-0.45
SLOPE	71.90	73.32
R SQR	1.00	0.99
STD ERR EST	0.08	0.17

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	15.00	3.86	23.27	21.76	-0.06	20.57	-0.12
16.00	85.00	42.98	26.53	32.24	0.22	32.64	0.23
86.00	295.00	174.44	47.88	49.65	0.04	52.30	0.09
296.00	505.00	393.10	40.95	33.73	-0.18	36.35	-0.11
506.00	1,255.00	838.75	97.50	83.97	-0.14	92.47	-0.05
STANDARD ERROR					0.143		0.134

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	28.32	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	2.95	49.50	

FIRST UNIT, LAST UNIT FOR PREDICT	1256	2565
PREDICTION WITH ELEMENTARY TECHNIQUE	100.57	
PREDICTION WITH CALOT TECHNIQUE	113.24	

AIM-7F (RAY) 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.74	0.74	0.75	0.01	0.74	-0.01
2.00	0.38	0.49	0.47	-0.04	0.47	-0.05
3.00	0.20	0.30	0.31	0.03	0.31	0.04
4.00	0.17	0.24	0.24	0.01	0.25	0.03
5.00	0.13	0.20	0.20	0.01	0.20	0.02
6.00	0.12	0.17	0.17	-0.00	0.17	0.02
7.00	0.11	0.16	0.16	-0.02	0.16	0.01
STANDARD ERROR				0.022		0.028

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	4.62	4.26
EXPONENT	-0.40	-0.38
SLOPE	76.04	76.70
R SQR	1.00	1.00
STD ERR EST	0.03	0.08

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	100.00	27.85	74.10	74.89	0.01	73.54	-0.01
101.00	325.00	197.48	85.05	77.86	-0.08	78.19	-0.08
326.00	925.00	589.22	119.40	134.79	0.13	137.22	0.15
926.00	1,725.00	1,296.14	135.20	131.62	-0.03	135.31	0.00
1,726.00	2,825.00	2,243.49	147.40	145.70	-0.01	150.82	0.02
2,826.00	4,225.00	3,492.23	162.40	155.68	-0.04	162.05	-0.00
4,226.00	5,125.00	4,664.86	99.90	89.26	-0.11	93.25	-0.07
STANDARD ERROR					0.073		0.070

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.36 F-TABLE 5.46 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.71 F-TABLE 5.46 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 5126 6269

PREDICTION WITH ELEMENTARY TECHNIQUE 104.94

PREDICTION WITH CALOT TECHNIQUE 109.90

ARC-54 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	21.00	21.00	20.88	-0.01	20.83	-0.01
2.00	16.50	18.81	19.06	0.01	19.01	0.01
3.00	16.40	17.75	17.61	-0.01	17.55	-0.01
4.00	14.50	16.87	16.87	-0.00	16.81	-0.00
5.00	14.40	16.71	16.72	0.00	16.65	-0.00
6.00	13.90	15.58	15.58	0.00	15.51	-0.00
STANDARD ERROR				0.007		0.008

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	52.78	53.01
EXPONENT	-0.14	-0.14
SLOPE	90.98	90.92
R SQR	1.00	0.99
STD ERR EST	0.01	0.03

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	900.00	306.32	18,900.00	18,788.04	-0.01	18,750.25	-0.01
901.00	1,753.00	1,299.78	14,074.50	14,627.15	0.04	14,571.72	0.04
1,754.00	3,134.00	2,405.72	22,648.40	21,774.59	-0.04	21,678.85	-0.04
3,135.00	4,294.00	3,696.78	16,820.00	17,249.55	0.03	17,166.31	0.02
4,295.00	4,594.00	4,442.27	4,320.00	4,350.74	0.01	4,328.96	0.00
4,595.00	7,697.00	6,070.06	43,131.70	43,125.65	-0.00	42,896.66	-0.01
STANDARD ERROR					0.025		0.024

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.00 F-TABLE 9.00 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.23 F-TABLE 9.00 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 7698 10347

PREDICTION WITH ELEMENTARY TECHNIQUE 34,912.50

PREDICTION WITH CALOT TECHNIQUE 34,713.29

ARC-109V 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	48.70	48.70	49.68	0.02	50.12	0.03
2.00	39.30	40.64	38.71	-0.05	38.47	-0.05
3.00	28.50	31.68	32.60	0.03	32.07	0.01
STANDARD ERROR				0.034		0.036

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	59.33	60.48
EXPONENT	-0.13	-0.14
SLOPE	91.50	91.02
R SQR	0.96	0.94
STD ERR EST	0.06	0.09

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	4.00	1.36	194.80	198.70	0.02	200.46	0.03
5.00	28.00	13.98	943.20	885.27	-0.06	876.72	-0.07
29.00	107.00	62.70	2,251.50	2,404.56	0.07	2,353.83	0.05
STANDARD ERROR					0.054		0.051

CURVE FIT WITH ELEMENTARY TECHNIQUE	F-CALC	F-TABLE	(90%)
	0.50	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	F-CALC	F-TABLE	(90%)
	0.50	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	108	333
PREDICTION WITH ELEMENTARY TECHNIQUE	5,898.47	
PREDICTION WITH CALOT TECHNIQUE	5,720.76	

ASN-108 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	13.75	13.75	13.41	-0.02	13.21	-0.04
2.00	10.48	11.15	11.34	0.02	11.32	0.01
3.00	8.74	9.55	10.10	0.06	10.18	0.07
4.00	9.43	9.47	9.04	-0.05	9.19	-0.03
STANDARD ERROR				0.040		0.042

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	16.71	16.17
EXPONENT	-0.11	-0.10
SLOPE	92.92	93.47
R SQR	0.97	0.92
STD ERR EST	0.06	0.10

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	8.00	2.79	110.00	107.26	-0.02	105.66	-0.04
9.00	39.00	21.40	325.00	334.89	0.03	335.73	0.03
40.00	116.00	73.78	673.00	729.61	0.08	739.15	0.10
117.00	332.00	213.91	2,037.00	1,828.52	-0.10	1,869.13	-0.08
STANDARD ERROR					0.069		0.069

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	333	440
PREDICTION WITH ELEMENTARY TECHNIQUE	859.16	
PREDICTION WITH CALOT TECHNIQUE	882.63	

ASQ-133 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	58.57	58.57	60.56	0.03	61.62	0.05
2.00	58.63	58.61	55.25	-0.06	55.87	-0.05
3.00	42.54	47.79	49.03	0.03	49.17	0.03
STANDARD ERROR				0.041		0.044

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	80.29	83.24
EXPONENT	-0.11	-0.11
SLOPE	92.86	92.40
R SQR	0.81	0.64
STD ERR EST	0.07	0.16

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	14.00	4.83	820.00	847.79	0.03	862.62	0.05
15.00	33.00	22.76	1,114.00	975.61	-0.12	981.02	-0.12
34.00	101.00	63.57	2,893.00	3,128.55	0.08	3,122.82	0.08
STANDARD ERROR					0.088		0.088

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.50 F-TABLE 2.81 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.50 F-TABLE 2.81 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 102 168

PREDICTION WITH ELEMENTARY TECHNIQUE 2,849.03

PREDICTION WITH CALOT TECHNIQUE 2,828.61

ASW-32 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	23.42	23.42	23.51	0.00	24.36	0.04
2.00	16.42	18.63	18.78	0.01	18.68	0.00
3.00	15.25	16.74	16.03	-0.04	15.48	-0.08
4.00	9.75	14.24	14.70	0.03	13.98	-0.02
STANDARD ERROR				0.027		0.044

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	38.11	43.01
EXPONENT	-0.19	-0.23
SLOPE	87.39	85.29
R SQR	0.99	0.94
STD ERR EST	0.04	0.16

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	12.00	3.82	281.00	282.07	0.00	292.31	0.04
13.00	38.00	23.50	427.00	431.74	0.01	417.45	-0.02
39.00	86.00	60.01	732.00	664.35	-0.09	621.48	-0.15
87.00	134.00	108.91	468.00	591.73	0.26	542.01	0.16
STANDARD ERROR					0.140		0.112

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	135	184
PREDICTION WITH ELEMENTARY TECHNIQUE	573.23	
PREDICTION WITH CALOT TECHNIQUE	518.23	

B-52 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	112.50	112.50	108.89	-0.03	104.05	-0.08
2.00	37.00	60.97	63.50	0.04	62.63	0.03
3.00	28.60	51.77	54.27	0.05	54.08	0.04
4.00	32.30	42.69	40.39	-0.05	41.07	-0.04
STANDARD ERROR				0.045		0.049

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	445.06	370.32
EXPONENT	-0.47	-0.43
SLOPE	72.20	74.11
R SQR	0.99	0.96
STD ERR EST	0.06	0.21

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	20.00	5.09	2,250.00	2,177.76	-0.03	2,080.99	-0.08
21.00	63.00	38.53	1,591.00	1,822.92	0.15	1,864.74	0.17
64.00	88.00	74.98	715.00	775.33	0.08	812.96	0.14
89.00	165.00	123.53	2,487.10	1,888.47	-0.24	2,017.88	-0.19
STANDARD ERROR					0.148		0.150

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	166	298
PREDICTION WITH ELEMENTARY TECHNIQUE	2,452.36	
PREDICTION WITH CALOT TECHNIQUE	2,680.06	

B-58 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	51.28	51.28	51.73	0.01	53.11	0.04
2.00	31.76	40.22	39.68	-0.01	39.87	-0.01
3.00	23.60	31.15	30.91	-0.01	30.47	-0.02
4.00	17.84	28.06	28.42	0.01	27.84	-0.01
STANDARD ERROR				0.011		0.022

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	116.64	125.22
EXPONENT	-0.32	-0.34
SLOPE	80.27	79.10
R SQR	1.00	0.99
STD ERR EST	0.02	0.08

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	13.00	3.73	666.70	672.47	0.01	690.48	0.04
14.00	30.00	20.70	539.90	518.01	-0.04	505.58	-0.06
31.00	66.00	46.40	849.50	849.36	-0.00	814.87	-0.04
67.00	86.00	75.70	356.90	404.21	0.13	383.64	0.07
STANDARD ERROR					0.069		0.056

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.00 F-TABLE 2.81 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.00 F-TABLE 2.81 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 87 116

PREDICTION WITH ELEMENTARY TECHNIQUE 554.23

PREDICTION WITH CALOT TECHNIQUE 522.87

C-5A 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	197.60	197.60	201.92	0.02	205.62	0.04
2.00	111.73	144.75	139.40	-0.04	140.52	-0.03
3.00	65.92	98.98	99.51	0.01	99.65	0.01
4.00	52.24	77.22	78.05	0.01	77.84	0.01
STANDARD ERROR				0.022		0.026

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	376.92	380.19
EXPONENT	-0.39	-0.39
SLOPE	76.43	76.23
R SQR	1.00	0.99
STD ERR EST	0.03	0.10

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	5.00	1.35	988.00	1,009.61	0.02	1,028.12	0.04
6.00	13.00	8.55	893.80	802.54	-0.10	798.68	-0.11
14.00	31.00	21.08	1,186.50	1,272.78	0.07	1,262.26	0.06
32.00	58.00	43.50	1,410.50	1,441.97	0.02	1,425.85	0.01
STANDARD ERROR					0.065		0.066

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.00 F-TABLE 2.81 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.00 F-TABLE 2.81 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 59 81

PREDICTION WITH ELEMENTARY TECHNIQUE 1,027.06

PREDICTION WITH CALOT TECHNIQUE 1,013.57

C-47 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	6.18	6.18	6.70	0.08	6.81	0.10
2.00	5.23	5.64	5.46	-0.03	5.55	-0.02
3.00	4.56	5.24	4.90	-0.07	4.98	-0.05
4.00	3.46	4.39	4.19	-0.05	4.26	-0.03
5.00	2.76	3.80	3.76	-0.01	3.82	0.01
6.00	2.31	3.13	3.26	0.04	3.32	0.06
7.00	2.31	2.98	3.10	0.04	3.15	0.06
8.00	2.70	2.91	2.90	-0.00	2.95	0.01
STANDARD ERROR				0.047		0.051

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	13.46	13.61
EXPONENT	-0.24	-0.24
SLOPE	84.61	84.67
R SQR	1.00	0.98
STD ERR EST	0.05	0.13

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	18.00	5.71	111.26	120.65	0.08	122.51	0.10
19.00	42.00	28.96	125.42	108.85	-0.13	110.60	-0.12
43.00	66.00	53.44	109.42	93.90	-0.14	95.47	-0.13
67.00	126.00	94.00	207.54	204.87	-0.01	208.41	0.00
127.00	198.00	160.32	198.72	216.15	0.09	220.01	0.11
199.00	358.00	273.11	369.12	422.43	0.14	430.22	0.17
359.00	442.00	399.08	194.29	202.40	0.04	206.21	0.06
443.00	585.00	511.42	385.39	324.56	-0.16	330.75	-0.14
STANDARD ERROR					0.112		0.114

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 4.25 F-TABLE 4.32 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 2.06 F-TABLE 4.32 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 586 630

PREDICTION WITH ELEMENTARY TECHNIQUE 97.99

PREDICTION WITH CALOT TECHNIQUE 99.88

C-133 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	25.98	25.98	25.88	-0.00	25.14	-0.03
2.00	16.61	20.49	20.92	0.02	21.62	0.06
3.00	19.67	20.35	20.00	-0.02	20.94	0.03
STANDARD ERROR				0.016		0.041

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	47.10	38.36
EXPONENT	-0.24	-0.17
SLOPE	84.62	88.86
R SQR	0.98	0.68
STD ERR EST	0.03	0.18

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	12.00	3.99	311.70	310.55	-0.00	301.70	-0.03
13.00	29.00	19.78	282.40	296.20	0.05	325.35	0.15
30.00	35.00	31.94	118.00	93.09	-0.21	105.82	-0.10
STANDARD ERROR					0.125		0.108

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.50 F-TABLE 2.81 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.50 F-TABLE 2.81 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 36 50

PREDICTION WITH ELEMENTARY TECHNIQUE 217.60

PREDICTION WITH CALOT TECHNIQUE 252.25

CH-46 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	7.54	7.54	7.55	0.00	7.57	0.00
2.00	3.90	4.92	4.90	-0.00	4.90	-0.00
3.00	2.77	3.74	3.75	0.00	3.74	0.00
STANDARD ERROR				0.002		0.003

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	18.48	18.28
EXPONENT	-0.34	-0.34
SLOPE	79.04	79.12
R SQR	1.00	1.00
STD ERR EST	0.00	0.01

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	14.00	4.02	105.57	105.70	0.00	105.93	0.00
15.00	50.00	29.48	140.33	139.41	-0.01	138.90	-0.01
51.00	110.00	77.34	165.96	167.57	0.01	167.11	0.01
STANDARD ERROR					0.007		0.007

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.50	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.50	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	111	195
PREDICTION WITH ELEMENTARY TECHNIQUE	189.74	
PREDICTION WITH CALOT TECHNIQUE	189.33	

EA-6B 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	10.66	10.66	10.60	-0.01	10.73	0.01
2.00	8.53	9.16	9.32	0.02	9.31	0.02
3.00	8.53	8.91	8.84	-0.01	8.79	-0.01
4.00	7.83	8.59	8.52	-0.01	8.44	-0.02
5.00	6.91	8.34	8.37	0.00	8.28	-0.01
STANDARD ERROR				0.010		0.013

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	12.56	12.91
EXPONENT	-0.11	-0.12
SLOPE	92.96	92.31
R SQR	1.00	0.97
STD ERR EST	0.01	0.06

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	5.00	1.73	53.30	53.01	-0.01	53.63	0.01
6.00	17.00	10.34	102.40	105.42	0.03	104.67	0.02
18.00	28.00	22.25	93.80	89.16	-0.05	87.83	-0.06
29.00	40.00	33.80	94.00	93.07	-0.01	91.30	-0.03
41.00	47.00	43.45	48.40	52.87	0.09	51.74	0.07
STANDARD ERROR					0.049		0.045

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	4.38	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	3.14	49.50	

FIRST UNIT, LAST UNIT FOR PREDICT 48 53

PREDICTION WITH ELEMENTARY TECHNIQUE 44.66

PREDICTION WITH CALOT TECHNIQUE 43.64

E-2C 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	11.82	11.82	11.84	0.00	11.88	0.00
2.00	9.51	10.85	10.80	-0.00	10.80	-0.00
3.00	8.49	10.09	10.12	0.00	10.10	0.00
STANDARD ERROR				0.003		0.004

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	17.73	17.95
EXPONENT	-0.17	-0.17
SLOPE	88.98	88.72
R SQR	1.00	0.99
STD ERR EST	0.01	0.03

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	11.00	3.64	130.00	130.24	0.00	130.64	0.00
12.00	19.00	14.79	76.10	74.93	-0.02	74.59	-0.02
20.00	28.00	23.33	76.40	78.07	0.02	77.56	0.02
STANDARD ERROR					0.015		0.015

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.50	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.50	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT 29 34

PREDICTION WITH ELEMENTARY TECHNIQUE 49.63

PREDICTION WITH CALOT TECHNIQUE 49.25

F-3D 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	7.83	7.83	7.70	-0.02	7.54	-0.04
2.00	3.64	4.09	4.34	0.06	4.45	0.09
3.00	3.25	3.59	3.44	-0.04	3.59	0.00
STANDARD ERROR				0.044		0.056

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	10.20	9.75
EXPONENT	-0.26	-0.24
SLOPE	83.73	84.94
R SQR	0.98	0.96
STD ERR EST	0.08	0.14

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	3.00	0.95	23.50	23.09	-0.02	22.62	-0.04
4.00	28.00	12.92	91.00	98.54	0.08	102.04	0.12
29.00	70.00	47.05	136.50	118.84	-0.13	126.44	-0.07
STANDARD ERROR					0.089		0.085

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.50	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.50	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT 71 167

PREDICTION WITH ELEMENTARY TECHNIQUE 218.70

PREDICTION WITH CALOT TECHNIQUE 236.95

F-4 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	20.33	20.33	20.92	0.03	21.60	0.06
2.00	18.64	19.15	17.74	-0.07	17.35	-0.09
3.00	11.63	15.31	16.06	0.05	15.21	-0.01
STANDARD ERROR				0.054		0.065

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	27.42	30.85
EXPONENT	-0.14	-0.18
SLOPE	90.82	88.04
R SQR	0.80	0.70
STD ERR EST	0.10	0.23

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	7.00	2.30	142.30	146.46	0.03	151.22	0.06
8.00	23.00	14.09	298.20	261.48	-0.12	247.83	-0.17
24.00	47.00	34.16	279.00	346.91	0.24	315.91	0.13
STANDARD ERROR					0.158		0.129

CURVE FIT WITH ELEMENTARY TECHNIQUE	F-CALC	F-TABLE	(90%)
	0.50	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	F-CALC	F-TABLE	(90%)
	0.50	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT 48 119

PREDICTION WITH ELEMENTARY TECHNIQUE 925.03

PREDICTION WITH CALOT TECHNIQUE 810.97

F-5 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	5.20	5.20	5.43	0.04	5.52	0.06
2.00	3.31	3.67	3.39	-0.08	3.41	-0.07
3.00	1.56	1.85	1.91	0.04	1.91	0.03
STANDARD ERROR				0.056		0.058

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	8.61	8.79
EXPONENT	-0.29	-0.29
SLOPE	82.02	81.75
R SQR	0.98	0.97
STD ERR EST	0.10	0.16

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	5.00	1.52	26.00	27.17	0.04	27.60	0.06
6.00	26.00	13.73	69.50	60.99	-0.12	61.11	-0.12
27.00	192.00	92.52	258.90	279.30	0.08	277.38	0.07
STANDARD ERROR					0.088		0.088

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.50	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.50	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	193	406
PREDICTION WITH ELEMENTARY TECHNIQUE	259.75	
PREDICTION WITH CALOT TECHNIQUE	256.38	

F-6 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	17.25	17.25	18.27	0.06	18.60	0.08
2.00	9.21	10.45	9.50	-0.09	9.62	-0.08
3.00	2.89	3.29	3.42	0.04	3.44	0.04
STANDARD ERROR				0.066		0.069

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	23.28	23.64
EXPONENT	-0.35	-0.35
SLOPE	78.50	78.40
R SQR	0.99	0.98
STD ERR EST	0.12	0.17

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	2.00	0.58	34.50	36.55	0.06	37.20	0.08
3.00	13.00	6.42	101.30	87.00	-0.14	87.86	-0.13
14.00	243.00	95.87	664.70	707.00	0.06	710.81	0.07
STANDARD ERROR					0.096		0.098

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.50	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.50	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	244	421
PREDICTION WITH ELEMENTARY TECHNIQUE	357.08	
PREDICTION WITH CALOT TECHNIQUE	357.72	

F-14 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	50.37	50.37	50.88	0.01	50.93	0.01
2.00	27.20	38.78	38.25	-0.01	38.39	-0.01
3.00	17.06	23.92	23.81	-0.00	24.06	0.01
4.00	11.03	16.72	17.01	0.02	17.29	0.03
5.00	9.97	14.31	14.18	-0.01	14.46	0.01
STANDARD ERROR				0.012		0.017

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	106.32	103.56
EXPONENT	-0.41	-0.40
SLOPE	75.19	75.66
R SQR	1.00	1.00
STD ERR EST	0.02	0.07

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	6.00	1.62	302.20	305.26	0.01	305.58	0.01
7.00	12.00	8.75	163.20	153.79	-0.06	155.08	-0.05
13.00	38.00	23.26	443.50	445.69	0.00	453.48	0.02
39.00	86.00	59.70	529.30	558.50	0.06	572.96	0.08
87.00	134.00	108.74	478.70	436.47	-0.09	450.11	-0.06
STANDARD ERROR					0.053		0.052

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.37 F-TABLE 49.50 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.37 F-TABLE 49.50 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 135 184

PREDICTION WITH ELEMENTARY TECHNIQUE 389.83

PREDICTION WITH CALOT TECHNIQUE 403.32

F-15A/B 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	25.60	25.60	25.61	0.00	25.63	0.00
2.00	19.56	21.53	21.49	-0.00	21.48	-0.00
3.00	17.18	19.62	19.64	0.00	19.62	-0.00
STANDARD ERROR				0.001		0.001

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	43.58	43.71
EXPONENT	-0.16	-0.16
SLOPE	89.73	89.66
R SQR	1.00	1.00
STD ERR EST	0.00	0.01

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	30.00	10.07	767.91	768.28	0.00	768.86	0.00
31.00	92.00	57.74	1,212.47	1,209.25	-0.00	1,207.64	-0.00
93.00	164.00	126.00	1,237.18	1,243.09	0.00	1,240.59	0.00
STANDARD ERROR					0.003		0.003

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.50	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.50	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	165	272
PREDICTION WITH ELEMENTARY TECHNIQUE	1,714.77	
PREDICTION WITH CALOT TECHNIQUE	1,710.55	

F-16A/B 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	10.14	10.14	10.17	0.00	10.56	0.04
2.00	7.74	8.75	8.84	0.01	8.82	0.01
3.00	8.04	8.46	8.11	-0.04	7.91	-0.06
4.00	5.05	7.44	7.66	0.03	7.35	-0.01
STANDARD ERROR				0.026		0.039

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	21.64	27.47
EXPONENT	-0.16	-0.21
SLOPE	89.36	86.70
R SQR	0.97	0.86
STD ERR EST	0.04	0.19

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	105.00	34.00	1,064.70	1,068.21	0.00	1,108.52	0.04
106.00	250.00	171.24	1,122.30	1,141.28	0.02	1,097.46	-0.02
251.00	425.00	332.82	1,407.00	1,236.85	-0.12	1,155.16	-0.18
426.00	605.00	511.78	909.00	1,186.48	0.31	1,087.47	0.20
STANDARD ERROR					0.164		0.135

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	606	725
PREDICTION WITH ELEMENTARY TECHNIQUE	758.32	
PREDICTION WITH CALOT TECHNIQUE	687.16	

F-84 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	2.20	2.20	2.27	0.03	2.34	0.06
2.00	1.30	1.52	1.43	-0.06	1.43	-0.06
3.00	0.75	1.07	1.07	-0.00	1.04	-0.03
4.00	0.57	0.85	0.88	0.03	0.85	-0.00
STANDARD ERROR				0.039		0.047

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	6.63	7.21
EXPONENT	-0.33	-0.35
SLOPE	79.38	78.50
R SQR	0.99	0.99
STD ERR EST	0.06	0.12

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	25.00	7.11	54.90	56.74	0.03	58.39	0.06
26.00	100.00	56.77	97.40	86.27	-0.11	84.14	-0.14
101.00	241.00	163.49	105.70	114.10	0.08	108.91	0.03
242.00	432.00	330.14	109.00	122.33	0.12	115.13	0.06
STANDARD ERROR					0.094		0.082

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	433	586
PREDICTION WITH ELEMENTARY TECHNIQUE	85.55	
PREDICTION WITH CALOT TECHNIQUE	79.83	

F-89 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	11.70	11.70	12.46	0.07	12.52	0.07
2.00	7.38	7.55	6.35	-0.16	6.05	-0.20
3.00	3.82	5.46	5.34	-0.02	5.02	-0.08
4.00	2.98	4.30	4.68	0.09	4.36	0.01
5.00	3.47	3.91	4.09	0.05	3.77	-0.04
STANDARD ERROR				0.090		0.102

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	14.41	14.63
EXPONENT	-0.21	-0.23
SLOPE	86.49	85.51
R SQR	0.98	0.97
STD ERR EST	0.12	0.20

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	2.00	0.64	23.40	24.92	0.07	25.04	0.07
3.00	50.00	19.66	354.20	292.61	-0.17	277.46	-0.22
51.00	114.00	79.34	244.60	291.67	0.19	269.99	0.10
115.00	214.00	160.80	298.30	393.08	0.32	359.66	0.21
215.00	407.00	304.20	670.50	663.83	-0.01	601.09	-0.10
STANDARD ERROR					0.186		0.152

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 5.67 F-TABLE 49.50 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 1.82 F-TABLE 49.50 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 408 579

PREDICTION WITH ELEMENTARY TECHNIQUE 535.44

PREDICTION WITH CALOT TECHNIQUE 481.04

F-100 AIRFRAME 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	3.22	3.22	3.16	-0.02	3.11	-0.04
2.00	2.12	2.46	2.58	0.05	2.59	0.05
3.00	2.20	2.35	2.34	-0.01	2.38	0.01
4.00	2.01	2.25	2.21	-0.02	2.26	0.00
STANDARD ERROR				0.028		0.033

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	8.01	7.01
EXPONENT	-0.17	-0.15
SLOPE	88.59	89.92
R SQR	0.98	0.94
STD ERR EST	0.04	0.09

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	203.00	68.37	654.60	642.20	-0.02	630.38	-0.04
204.00	654.00	403.93	955.30	1,044.06	0.09	1,066.55	0.12
655.00	1,150.00	888.60	1,092.20	1,000.26	-0.08	1,039.38	-0.05
1,151.00	1,594.00	1,365.03	891.30	830.63	-0.07	871.13	-0.02
STANDARD ERROR					0.072		0.067

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	1595	1889
PREDICTION WITH ELEMENTARY TECHNIQUE	529.00	
PREDICTION WITH CALOT TECHNIQUE	557.69	

F-100 ENGINE 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	3.75	3.75	3.75	0.00	3.76	0.00
2.00	3.21	3.45	3.46	0.00	3.46	0.00
3.00	2.99	3.21	3.20	-0.00	3.20	-0.00
4.00	2.76	3.03	3.03	0.00	3.03	0.00
STANDARD ERROR				0.002		0.002

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	5.73	5.77
EXPONENT	-0.10	-0.11
SLOPE	93.06	92.97
R SQR	1.00	1.00
STD ERR EST	0.00	0.01

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	59.00	20.49	221.50	221.54	0.00	221.85	0.00
60.00	131.00	92.39	231.00	231.29	0.00	231.07	0.00
132.00	276.00	198.59	432.90	430.25	-0.01	429.39	-0.01
277.00	461.00	364.15	510.80	515.47	0.01	514.01	0.01
STANDARD ERROR					0.006		0.005

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	462	773
PREDICTION WITH ELEMENTARY TECHNIQUE	824.08	
PREDICTION WITH CALOT TECHNIQUE	821.15	

F-101 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	16.85	16.85	16.16	-0.04	15.72	-0.07
2.00	7.58	10.08	10.96	0.09	10.82	0.07
3.00	6.91	7.77	7.45	-0.04	7.47	-0.04
STANDARD ERROR				0.061		0.062

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	44.66	41.47
EXPONENT	-0.30	-0.28
SLOPE	81.45	82.17
R SQR	0.97	0.90
STD ERR EST	0.10	0.21

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	31.00	9.46	522.35	500.93	-0.04	487.32	-0.07
32.00	115.00	67.28	636.72	759.65	0.19	757.43	0.19
116.00	424.00	248.55	2,135.19	1,897.96	-0.11	1,923.93	-0.10
STANDARD ERROR					0.131		0.129

CURVE FIT WITH ELEMENTARY TECHNIQUE	F-CALC	F-TABLE	(90%)
	0.50	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	F-CALC	F-TABLE	(90%)
	0.50	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	425	630
PREDICTION WITH ELEMENTARY TECHNIQUE	1,015.45	
PREDICTION WITH CALOT TECHNIQUE	1,039.02	

F-102 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	34.55	34.55	32.84	-0.05	30.74	-0.11
2.00	5.17	12.67	13.93	0.10	13.09	0.03
3.00	3.50	5.38	5.15	-0.04	4.98	-0.07
STANDARD ERROR				0.069		0.079

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	317.12	232.68
EXPONENT	-0.63	-0.59
SLOPE	64.71	66.35
R SQR	0.99	0.95
STD ERR EST	0.12	0.38

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	37.00	6.72	1,278.42	1,214.98	-0.05	1,137.24	-0.11
38.00	145.00	80.94	558.36	804.39	0.44	761.27	0.36
146.00	707.00	365.96	1,967.00	1,621.12	-0.18	1,621.82	-0.18
STANDARD ERROR					0.275		0.242

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.50 F-TABLE 2.81 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.49 F-TABLE 2.81 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 708 847

PREDICTION WITH ELEMENTARY TECHNIQUE 253.07

PREDICTION WITH CALOT TECHNIQUE 259.06

F-105 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	10.60	10.60	11.33	0.07	11.61	0.09
2.00	10.74	10.64	10.07	-0.05	10.40	-0.02
3.00	6.19	8.76	8.40	-0.04	8.78	0.00
4.00	4.48	6.78	6.84	0.01	7.26	0.07
5.00	4.02	5.75	5.86	0.02	6.29	0.09
6.00	3.83	5.19	5.24	0.01	5.66	0.09
7.00	4.91	5.18	5.15	-0.01	5.57	0.08
STANDARD ERROR				0.038		0.073

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	44.92	41.34
EXPONENT	-0.33	-0.31
SLOPE	79.56	80.93
R SQR	1.00	0.96
STD ERR EST	0.04	0.23

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	65.00	19.44	689.20	736.60	0.07	754.63	0.09
66.00	93.00	78.45	300.60	199.82	-0.34	212.32	-0.29
94.00	161.00	124.96	420.90	416.19	-0.01	447.32	0.06
162.00	300.00	225.78	622.80	699.89	0.12	763.29	0.23
301.00	480.00	385.36	724.10	759.74	0.05	839.59	0.16
481.00	675.00	573.85	747.40	721.72	-0.03	805.45	0.08
676.00	711.00	692.89	176.70	125.20	-0.29	140.38	-0.21
STANDARD ERROR					0.178		0.179

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 1.88 F-TABLE 5.46 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 1.17 F-TABLE 5.46 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 712 818

PREDICTION WITH ELEMENTARY TECHNIQUE 360.38

PREDICTION WITH CALOT TECHNIQUE 405.04

F-106 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	42.29	42.29	42.01	-0.01	40.06	-0.05
2.00	10.54	20.80	21.46	0.03	21.99	0.06
3.00	11.64	18.44	17.99	-0.02	18.83	0.02
STANDARD ERROR				0.024		0.047

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	387.37	236.94
EXPONENT	-0.59	-0.50
SLOPE	66.23	70.76
R SQR	1.00	0.92
STD ERR EST	0.04	0.31

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	42.00	8.81	1,775.98	1,764.34	-0.01	1,682.58	-0.05
43.00	130.00	79.45	927.52	1,025.81	0.11	1,176.61	0.27
131.00	175.00	151.60	523.80	357.55	-0.32	435.83	-0.17
STANDARD ERROR					0.195		0.165

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.50 F-TABLE 2.81 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.50 F-TABLE 2.81 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 176 340

PREDICTION WITH ELEMENTARY TECHNIQUE 973.24

PREDICTION WITH CALOT TECHNIQUE 1,243.22

F-111 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	35.96	35.96	35.97	0.00	36.17	0.01
2.00	17.05	19.19	19.15	-0.00	18.87	-0.02
3.00	12.73	18.34	18.38	0.00	18.09	-0.01
STANDARD ERROR				0.002		0.013

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	83.01	85.06
EXPONENT	-0.29	-0.30
SLOPE	81.83	81.57
R SQR	1.00	1.00
STD ERR EST	0.00	0.03

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	18.00	5.41	647.30	647.39	0.00	650.99	0.01
19.00	159.00	75.32	2,404.20	2,397.06	-0.00	2,348.97	-0.02
160.00	183.00	170.81	305.50	319.86	0.05	310.91	0.02
STANDARD ERROR					0.027		0.017

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.50	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.50	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	184	277
PREDICTION WITH ELEMENTARY TECHNIQUE	1,152.47	
PREDICTION WITH CALOT TECHNIQUE	1,117.64	

F-404 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	2.78	2.78	2.78	0.00	2.79	0.01
2.00	2.45	2.54	2.52	-0.01	2.51	-0.01
3.00	2.21	2.39	2.40	0.01	2.39	-0.00
STANDARD ERROR				0.006		0.007

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	3.31	3.36
EXPONENT	-0.08	-0.08
SLOPE	94.73	94.38
R SQR	0.99	0.98
STD ERR EST	0.01	0.02

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	9.00	3.17	25.00	25.06	0.00	25.15	0.01
10.00	33.00	19.65	58.70	57.97	-0.01	57.59	-0.02
34.00	60.00	45.78	59.60	61.05	0.02	60.38	0.01
STANDARD ERROR					0.016		0.014

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.50 F-TABLE 2.81 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.50 F-TABLE 2.81 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 61 114

PREDICTION WITH ELEMENTARY TECHNIQUE 116.30

PREDICTION WITH CALOT TECHNIQUE 114.63

GBU-15 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	19.75	19.75	20.55	0.04	20.71	0.05
2.00	20.00	19.90	18.64	-0.06	18.89	-0.05
3.00	14.39	15.69	16.10	0.03	16.47	0.05
4.00	14.83	15.38	15.39	0.00	15.78	0.03
STANDARD ERROR				0.040		0.045

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	29.85	29.42
EXPONENT	-0.10	-0.10
SLOPE	93.23	93.62
R SQR	0.94	0.87
STD ERR EST	0.06	0.11

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	40.00	13.97	790.00	821.91	0.04	828.49	0.05
41.00	105.00	69.70	1,300.00	1,134.83	-0.13	1,155.44	-0.11
106.00	445.00	253.76	4,893.00	5,208.43	0.06	5,344.75	0.09
446.00	695.00	564.95	3,708.00	3,531.63	-0.05	3,641.87	-0.02
STANDARD ERROR					0.078		0.077

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	696	1015
PREDICTION WITH ELEMENTARY TECHNIQUE	4,337.66	
PREDICTION WITH CALOT TECHNIQUE	4,484.17	

H-34 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	6,468.00	6,468.00	5,802.55	-0.10	5,405.66	-0.16
2.00	975.28	1,183.86	1,503.92	0.27	1,603.08	0.35
3.00	932.50	1,057.39	1,126.74	0.07	1,235.92	0.17
4.00	576.60	811.10	837.73	0.03	946.60	0.17
5.00	615.96	740.45	695.86	-0.06	801.12	0.08
6.00	547.51	725.48	673.03	-0.07	777.45	0.07
7.00	521.85	705.88	645.50	-0.09	748.79	0.06
STANDARD ERROR				0.123		0.179

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	9,132.26	8,077.16
EXPONENT	-0.41	-0.37
SLOPE	75.12	77.34
R SQR	1.00	0.99
STD ERR EST	0.14	0.22

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	3.00	0.85	19,404.00	17,407.66	-0.10	16,216.99	-0.16
4.00	79.00	29.33	74,121.00	101,401.80	0.37	110,426.60	0.49
80.00	159.00	115.80	74,600.00	60,342.90	-0.19	69,867.70	-0.06
160.00	326.00	235.65	96,293.00	93,947.34	-0.02	112,081.10	0.16
327.00	511.00	413.72	113,953.00	82,484.96	-0.28	100,781.90	-0.12
512.00	554.00	532.30	23,543.00	17,276.34	-0.27	21,335.83	-0.09
555.00	613.00	583.16	30,789.00	22,828.53	-0.26	28,301.10	-0.08
STANDARD ERROR					0.238		0.216

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	4.02	5.46	
CURVE FIT WITH THE CALOT TECHNIQUE	0.78	5.46	

FIRST UNIT, LAST UNIT FOR PREDICT	614	766
PREDICTION WITH ELEMENTARY TECHNIQUE	55,310.13	
PREDICTION WITH CALOT TECHNIQUE	69,045.04	

H-37 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	12,793.00	12,793.00	12,688.26	-0.01	13,268.10	0.04
2.00	5,146.68	6,189.36	6,475.61	0.05	6,638.86	0.07
3.00	4,725.78	5,764.45	5,767.66	0.00	5,893.94	0.02
4.00	4,349.47	5,303.04	4,976.19	-0.06	4,906.25	-0.07
5.00	2,734.17	4,092.43	4,039.91	-0.01	4,004.15	-0.02
6.00	2,181.52	3,720.86	3,761.07	0.01	3,731.25	0.00
STANDARD ERROR				0.032		0.047

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	18,385.52	19,275.24
EXPONENT	-0.34	-0.35
SLOPE	79.14	78.70
R SQR	1.00	0.99
STD ERR EST	0.03	0.16

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	3.00	0.86	38,379.00	38,064.79	-0.01	39,804.31	0.04
4.00	22.00	10.52	97,787.00	104,398.60	0.07	106,250.70	0.09
23.00	31.00	26.32	42,532.00	36,333.98	-0.15	36,657.19	-0.14
34.00	48.00	40.18	65,242.00	52,499.66	-0.20	52,787.63	-0.19
49.00	89.00	67.07	112,101.00	120,694.50	0.08	120,869.80	0.08
90.00	110.00	99.25	45,812.00	54,166.40	0.18	54,067.46	0.18
STANDARD ERROR					0.131		0.131

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 2.96 F-TABLE 9.00 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 3.48 F-TABLE 9.00 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 111 130

PREDICTION WITH ELEMENTARY TECHNIQUE 48,409.95

PREDICTION WITH CALOT TECHNIQUE 48,247.77

H-53 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	6.75	6.75	6.72	-0.00	6.77	0.00
2.00	4.26	4.44	4.52	0.02	4.47	0.01
3.00	3.76	4.10	4.08	-0.01	4.02	-0.02
4.00	3.38	4.07	4.05	-0.00	3.99	-0.02
5.00	3.34	4.00	3.99	-0.00	3.93	-0.02
6.00	3.15	3.98	3.98	-0.00	3.91	-0.02
STANDARD ERROR				0.008		0.016

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	9.50	9.70
EXPONENT	-0.15	-0.16
SLOPE	90.13	89.72
R SQR	1.00	1.00
STD ERR EST	0.01	0.04

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	10.00	3.36	67.52	67.25	-0.00	67.71	0.00
11.00	141.00	61.30	558.58	570.48	0.02	563.15	0.01
142.00	281.00	206.39	526.68	508.39	-0.03	497.70	-0.06
282.00	293.00	286.96	40.58	41.48	0.02	40.52	-0.00
294.00	323.00	307.86	100.23	102.61	0.02	100.18	-0.00
324.00	331.00	327.05	25.23	27.12	0.07	26.46	0.05
STANDARD ERROR					0.037		0.030

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.24	9.00	
CURVE FIT WITH THE CALOT TECHNIQUE	2.02	9.00	

FIRST UNIT, LAST UNIT FOR PREDICT	332	361
PREDICTION WITH ELEMENTARY TECHNIQUE	100.83	
PREDICTION WITH CALOT TECHNIQUE	98.37	

HH-52 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	1,327.75	1,327.75	1,318.66	-0.01	1,296.40	-0.02
2.00	929.07	1,188.67	1,199.44	0.01	1,188.10	-0.00
3.00	913.65	1,110.75	1,114.35	0.00	1,110.38	-0.00
4.00	852.07	1,059.01	1,060.75	0.00	1,061.22	0.00
5.00	876.00	1,033.77	1,026.54	-0.01	1,029.75	-0.00
STANDARD ERROR				0.006		0.011

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	2,752.91	2,539.67
EXPONENT	-0.22	-0.20
SLOPE	85.80	86.92
R SQR	1.00	0.98
STD ERR EST	0.01	0.05

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	28.00	9.09	37,177.00	36,922.43	-0.01	36,299.29	-0.02
29.00	43.00	35.18	13,936.00	14,653.50	0.05	14,789.03	0.06
44.00	60.00	51.21	15,532.00	15,284.80	-0.02	15,534.44	0.00
61.00	75.00	67.33	12,781.00	12,695.66	-0.01	12,968.93	0.01
76.00	87.00	80.91	10,512.00	9,752.54	-0.07	9,996.60	-0.05
STANDARD ERROR					0.041		0.037

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 6.46 F-TABLE 49.50 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 2.11 F-TABLE 49.50 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 88 99

PREDICTION WITH ELEMENTARY TECHNIQUE 9,458.92

PREDICTION WITH CALOT TECHNIQUE 9,720.55

HH-54 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	5.25	5.25	5.24	-0.00	5.24	-0.00
2.00	3.39	3.76	3.77	0.00	3.78	0.00
3.00	2.80	3.28	3.27	-0.00	3.28	0.00
STANDARD ERROR				0.002		0.003

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	7.57	7.52
EXPONENT	-0.20	-0.20
SLOPE	86.78	86.91
R SQR	1.00	1.00
STD ERR EST	0.00	0.01

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	6.00	1.95	31.49	31.46	-0.00	31.42	-0.00
7.00	30.00	16.17	81.31	81.70	0.00	81.91	0.01
31.00	60.00	43.96	84.03	83.23	-0.01	83.61	-0.00
STANDARD ERROR					0.006		0.005

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.50	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.50	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT 61 83

PREDICTION WITH ELEMENTARY TECHNIQUE 57.83

PREDICTION WITH CALOT TECHNIQUE 58.16

J-33 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.41	0.41	0.41	-0.01	0.39	-0.06
2.00	0.15	0.24	0.24	0.03	0.26	0.08
3.00	0.15	0.22	0.22	0.00	0.24	0.07
4.00	0.17	0.22	0.21	-0.03	0.23	0.05
STANDARD ERROR				0.020		0.065

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	8.36	4.19
EXPONENT	-0.46	-0.36
SLOPE	72.87	77.77
R SQR	1.00	0.94
STD ERR EST	0.03	0.20

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	730.00	202.97	302.50	300.44	-0.01	283.95	-0.06
731.00	2,287.00	1,407.46	239.60	258.29	0.08	300.04	0.25
2,288.00	2,825.00	2,549.38	83.20	67.96	-0.18	83.58	0.00
2,826.00	3,160.00	2,990.31	58.00	39.34	-0.32	49.12	-0.15
STANDARD ERROR					0.189		0.151

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT 3161 5044

PREDICTION WITH ELEMENTARY TECHNIQUE 192.65

PREDICTION WITH CALOT TECHNIQUE 247.40

J-35 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.53	0.53	0.56	0.05	0.57	0.07
2.00	0.44	0.45	0.40	-0.10	0.38	-0.14
3.00	0.31	0.40	0.38	-0.05	0.36	-0.10
4.00	0.26	0.33	0.35	0.04	0.32	-0.02
5.00	0.26	0.31	0.33	0.07	0.30	-0.01
STANDARD ERROR				0.065		0.082

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	0.98	1.10
EXPONENT	-0.14	-0.16
SLOPE	91.05	89.59
R SQR	0.96	0.97
STD ERR EST	0.09	0.12

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	65.00	21.83	34.60	36.34	0.05	36.94	0.07
66.00	759.00	340.52	303.70	267.99	-0.12	255.06	-0.16
760.00	1,200.00	969.78	136.80	147.91	0.08	137.28	0.00
1,201.00	2,273.00	1,703.66	277.80	333.46	0.20	305.45	0.10
2,274.00	3,495.00	2,858.70	317.00	354.09	0.12	320.45	0.01
STANDARD ERROR					0.124		0.090

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	26.78	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	3.79	49.50	

FIRST UNIT, LAST UNIT FOR PREDICT	3496	4282
PREDICTION WITH ELEMENTARY TECHNIQUE	218.81	
PREDICTION WITH CALOT TECHNIQUE	196.61	

J-57 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.96	0.96	0.98	0.01	0.98	0.02
2.00	0.85	0.86	0.84	-0.03	0.84	-0.03
3.00	0.74	0.78	0.78	-0.01	0.77	-0.02
4.00	0.67	0.72	0.74	0.02	0.72	0.00
STANDARD ERROR				0.018		0.021

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	1.38	1.42
EXPONENT	-0.07	-0.08
SLOPE	95.00	94.62
R SQR	0.99	0.98
STD ERR EST	0.03	0.04

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	103.00	36.31	99.20	100.59	0.01	101.31	0.02
104.00	783.00	387.18	576.80	557.42	-0.03	553.76	-0.04
784.00	2,247.00	1,447.58	1,082.10	1,088.46	0.01	1,073.15	-0.01
2,248.00	4,713.00	3,398.93	1,642.00	1,721.11	0.05	1,688.63	0.03
STANDARD ERROR					0.030		0.02

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.00 F-TABLE 2.81 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.00 F-TABLE 2.81 (90%

FIRST UNIT, LAST UNIT FOR PREDICT 4714 7752

PREDICTION WITH ELEMENTARY TECHNIQUE 2,029.52

PREDICTION WITH CALOT TECHNIQUE 1,984.44

J-60 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.25	0.25	0.25	-0.00	0.25	-0.01
2.00	0.24	0.24	0.24	0.00	0.24	0.01
3.00	0.23	0.24	0.24	0.01	0.24	0.02
4.00	0.25	0.24	0.24	-0.01	0.24	0.00
STANDARD ERROR				0.007		0.012

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	0.26	0.25
EXPONENT	-0.01	-0.01
SLOPE	99.09	99.42
R SQR	0.94	0.63
STD ERR EST	0.01	0.04

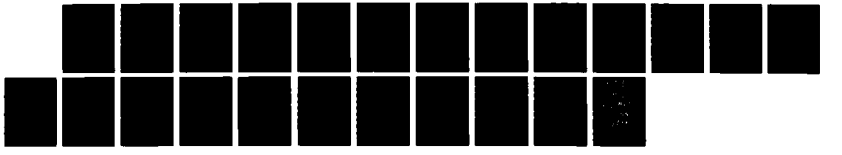
FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	14.00	5.13	3.50	3.49	-0.00	3.47	-0.01
15.00	221.00	97.80	49.60	49.70	0.00	50.12	0.01
222.00	440.00	324.22	50.80	51.75	0.02	52.49	0.03
441.00	647.00	540.24	51.20	48.58	-0.05	49.40	-0.04
STANDARD ERROR					0.027		0.025

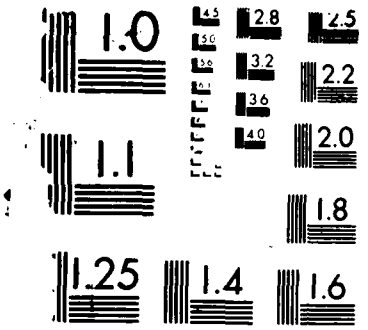
	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	648	691
PREDICTION WITH ELEMENTARY TECHNIQUE	10.30	
PREDICTION WITH CALOT TECHNIQUE	10.48	

AD-A187 127 A COMPARISON OF FITTING TECHNIQUES FOR THE CUMULATIVE AVERAGE LEARNING CU..(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF SYST.. J K JONES 3/3

UNCLASSIFIED SEP 87 AFIT/GSM/LSQ/87S-11 F/G 12/1 NL





J-69 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.07	0.07	0.07	0.01	0.07	0.04
2.00	0.07	0.07	0.07	-0.02	0.07	0.01
3.00	0.06	0.07	0.07	-0.00	0.07	0.02
4.00	0.06	0.07	0.07	-0.00	0.07	0.02
5.00	0.06	0.06	0.06	0.01	0.06	0.04
6.00	0.06	0.06	0.06	-0.01	0.06	0.02
STANDARD ERROR				0.011		0.027

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	0.12	0.13
EXPONENT	-0.09	-0.09
SLOPE	93.90	94.01
R SQR	0.99	0.89
STD ERR EST	0.01	0.08

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	401.00	140.53	28.60	29.01	0.01	29.67	0.04
402.00	504.00	451.45	7.70	6.70	-0.13	6.87	-0.11
505.00	1,056.00	761.71	33.80	34.25	0.01	35.13	0.04
1,057.00	1,299.00	1,175.28	14.50	14.50	-0.00	14.88	0.03
1,300.00	1,768.00	1,526.89	25.80	27.32	0.06	28.06	0.09
1,769.00	2,150.00	1,955.63	24.00	21.76	-0.09	22.35	-0.07
STANDARD ERROR					0.070		0.068

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.07	9.00	
CURVE FIT WITH THE CALOT TECHNIQUE	0.27	9.00	

FIRST UNIT, LAST UNIT FOR PREDICT	2151	2434
PREDICTION WITH ELEMENTARY TECHNIQUE	15.95	
PREDICTION WITH CALOT TECHNIQUE	16.39	

J-71 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	1.55	1.55	1.63	0.05	1.67	0.07
2.00	1.32	1.41	1.32	-0.07	1.35	-0.05
3.00	0.81	0.95	0.96	0.01	0.97	0.02
4.00	0.63	0.72	0.72	0.01	0.73	0.02
STANDARD ERROR				0.041		0.046

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	3.19	3.31
EXPONENT	-0.22	-0.23
SLOPE	85.77	85.52
R SQR	0.99	0.97
STD ERR EST	0.06	0.12

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	21.00	6.73	32.60	34.17	0.05	35.00	0.07
22.00	54.00	35.93	43.70	37.11	-0.15	37.68	-0.14
55.00	226.00	127.96	138.70	145.96	0.05	147.46	0.06
227.00	816.00	483.61	368.80	372.96	0.01	374.70	0.02
STANDARD ERROR					0.084		0.085

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	817	1062
PREDICTION WITH ELEMENTARY TECHNIQUE	134.38	
PREDICTION WITH CALOT TECHNIQUE	134.61	

J-75 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	1.32	1.32	1.32	0.01	1.32	-0.00
2.00	1.11	1.14	1.12	-0.02	1.12	-0.02
3.00	0.93	1.04	1.05	0.01	1.05	0.01
4.00	0.94	1.01	1.01	0.01	1.02	0.01
5.00	0.91	0.99	0.99	0.00	1.00	0.01
6.00	0.93	0.98	0.98	-0.00	0.98	0.00
STANDARD ERROR				0.010		0.011

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	1.94	1.89
EXPONENT	-0.10	-0.09
SLOPE	93.59	93.85
R SQR	1.00	0.99
STD ERR EST	0.01	0.04

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	53.00	18.56	69.80	70.22	0.01	69.74	-0.00
54.00	311.00	162.84	285.50	277.70	-0.03	278.27	-0.03
312.00	605.00	449.20	273.40	287.18	0.05	288.97	0.06
606.00	861.00	728.91	240.50	238.74	-0.01	240.71	0.00
862.00	1,065.00	961.01	186.20	185.29	-0.00	187.03	0.00
1,066.00	1,284.00	1,172.68	204.00	195.16	-0.04	197.15	-0.03
STANDARD ERROR					0.030		0.029

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.12	9.00	
CURVE FIT WITH THE CALOT TECHNIQUE	0.68	9.00	

FIRST UNIT, LAST UNIT FOR PREDICT	1285	1462
PREDICTION WITH ELEMENTARY TECHNIQUE	156.26	
PREDICTION WITH CALOT TECHNIQUE	157.96	

J-79 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	1.69	1.69	1.69	0.00	1.71	0.02
2.00	1.34	1.48	1.47	-0.01	1.47	-0.01
3.00	1.20	1.40	1.40	-0.00	1.38	-0.02
4.00	1.06	1.35	1.36	0.01	1.34	-0.01
STANDARD ERROR				0.005		0.013

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	4.22	4.78
EXPONENT	-0.16	-0.18
SLOPE	89.57	88.35
R SQR	1.00	0.98
STD ERR EST	0.01	0.05

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	316.00	104.37	532.70	534.13	0.00	540.75	0.02
317.00	749.00	514.35	578.30	569.71	-0.01	557.17	-0.04
750.00	1,055.00	896.83	366.10	368.62	0.01	356.51	-0.03
1,056.00	1,222.00	1,137.26	177.60	193.73	0.09	186.48	0.05
STANDARD ERROR					0.046		0.034

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.00 F-TABLE 2.81 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.00 F-TABLE 2.81 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 1223 1826

PREDICTION WITH ELEMENTARY TECHNIQUE 669.67

PREDICTION WITH CALOT TECHNIQUE 640.95

J-85 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.67	0.67	0.67	0.00	0.67	0.00
2.00	0.45	0.49	0.49	-0.00	0.49	-0.00
3.00	0.38	0.45	0.45	-0.00	0.44	-0.01
4.00	0.34	0.42	0.42	0.00	0.42	-0.00
STANDARD ERROR				0.003		0.006

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	1.64	1.68
EXPONENT	-0.18	-0.19
SLOPE	88.09	87.85
R SQR	1.00	1.00
STD ERR EST	0.00	0.02

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	135.00	44.44	90.40	90.45	0.00	90.82	0.00
136.00	761.00	397.96	281.20	281.10	-0.00	279.59	-0.01
762.00	1,246.00	991.69	186.70	184.31	-0.01	182.64	-0.02
1,247.00	1,694.00	1,463.16	153.30	158.55	0.03	156.89	0.02
STANDARD ERROR					0.018		0.016

CURVE FIT WITH ELEMENTARY TECHNIQUE	F-CALC	F-TABLE	(90%)
	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	F-CALC	F-TABLE	(90%)
	0.00	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	1695	2205
PREDICTION WITH ELEMENTARY TECHNIQUE	171.70	
PREDICTION WITH CALOT TECHNIQUE	169.71	

OH-58 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	135.20	135.20	134.53	-0.00	135.45	0.00
2.00	114.63	118.75	121.08	0.02	121.19	0.02
3.00	112.93	115.42	114.54	-0.01	114.29	-0.01
4.00	107.79	112.24	110.57	-0.01	110.11	-0.02
5.00	99.24	107.91	107.68	-0.00	107.07	-0.01
6.00	97.53	105.31	105.67	0.00	104.96	-0.00
7.00	95.81	103.41	104.14	0.01	103.35	-0.00
STANDARD ERROR				0.010		0.012

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	160.62	163.34
EXPONENT	-0.07	-0.07
SLOPE	95.56	95.32
R SQR	1.00	0.99
STD ERR EST	0.01	0.03

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	15.00	5.32	2,028.00	2,017.90	-0.00	2,031.76	0.00
16.00	75.00	40.98	6,878.00	7,062.80	0.03	7,057.14	0.03
76.00	175.00	121.30	11,293.00	10,964.51	-0.03	10,911.82	-0.03
176.00	300.00	234.52	13,474.00	13,126.84	-0.03	13,032.01	-0.03
301.00	450.00	372.31	14,886.00	15,282.82	0.03	15,146.58	0.02
451.00	600.00	523.08	14,629.00	14,946.52	0.02	14,794.69	0.01
601.00	750.00	673.51	14,372.00	14,701.18	0.02	14,538.37	0.01
STANDARD ERROR					0.024		0.022

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 1.01 F-TABLE 5.46 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 1.01 F-TABLE 5.46 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 751 900

PREDICTION WITH ELEMENTARY TECHNIQUE 14,508.73

PREDICTION WITH CALOT TECHNIQUE 14,337.30

P-3C 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	9.75	9.75	9.72	-0.00	9.45	-0.03
2.00	8.04	8.92	8.80	-0.01	8.72	-0.02
3.00	6.54	8.11	8.28	0.02	8.29	0.02
4.00	6.42	7.87	8.09	0.03	8.14	0.03
5.00	8.67	8.05	7.79	-0.03	7.89	-0.02
STANDARD ERROR				0.022		0.026

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	15.57	13.87
EXPONENT	-0.15	-0.12
SLOPE	90.24	91.98
R SQR	0.98	0.81
STD ERR EST	0.03	0.16

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	24.00	8.25	234.10	233.35	-0.00	226.89	-0.03
25.00	47.00	34.78	185.00	180.33	-0.03	182.79	-0.01
48.00	71.00	58.54	156.90	174.20	0.11	179.13	0.14
72.00	83.00	76.91	77.00	83.65	0.09	86.66	0.13
84.00	107.00	94.72	208.00	162.21	-0.22	169.03	-0.19
STANDARD ERROR					0.117		0.120

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	1.92	49.50	
CURVE FIT WITH THE CALOT TECHNIQUE	1.29	49.50	

FIRST UNIT, LAST UNIT FOR PREDICT	108	119
PREDICTION WITH ELEMENTARY TECHNIQUE	79.02	
PREDICTION WITH CALOT TECHNIQUE	82.74	

S-3A 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	14.59	14.59	14.58	-0.00	14.57	-0.00
2.00	8.33	10.03	10.05	0.00	10.05	0.00
3.00	6.52	8.33	8.32	-0.00	8.33	0.00
STANDARD ERROR				0.001		0.002

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	30.30	29.92
EXPONENT	-0.29	-0.28
SLOPE	82.07	82.23
R SQR	1.00	1.00
STD ERR EST	0.00	0.01

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	13.00	3.95	189.70	189.58	-0.00	189.42	-0.00
14.00	48.00	28.11	291.70	292.75	0.00	293.06	0.00
49.00	93.00	68.90	293.50	291.58	-0.01	292.56	-0.00
STANDARD ERROR					0.004		0.003

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.50	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.50	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT 94 138

PREDICTION WITH ELEMENTARY TECHNIQUE 252.26

PREDICTION WITH CALOT TECHNIQUE 253.45

SH-3 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	12,408.56	12,408.56	11,142.41	-0.10	9,215.11	-0.26
2.00	2,800.90	5,782.59	6,294.34	0.09	5,661.24	-0.02
3.00	2,087.43	3,461.27	3,883.44	0.12	3,755.04	0.08
4.00	1,952.25	2,742.21	2,831.50	0.03	2,871.73	0.05
5.00	1,524.51	2,459.75	2,489.28	0.01	2,574.41	0.05
6.00	1,574.11	2,321.13	2,290.81	-0.01	2,399.22	0.03
7.00	1,338.00	2,188.08	2,133.85	-0.02	2,259.06	0.03
8.00	1,433.83	2,111.63	2,025.41	-0.04	2,161.31	0.02
9.00	1,459.50	2,062.72	1,949.78	-0.05	2,092.69	0.01
STANDARD ERROR				0.066		0.095

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	32,564.33	22,663.58
EXPONENT	-0.49	-0.41
SLOPE	71.30	75.10
R SQR	1.00	0.99
STD ERR EST	0.07	0.22

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	9.00	2.43	111,677.00	100,281.70	-0.10	82,936.03	-0.26
10.00	29.00	17.64	56,018.00	82,254.08	0.47	81,239.84	0.45
30.00	78.00	50.67	102,284.00	120,372.40	0.18	128,717.20	0.26
79.00	149.00	110.78	138,610.00	118,985.20	-0.14	134,995.20	-0.03
150.00	194.00	170.79	68,603.00	61,025.88	-0.11	71,547.29	0.04
195.00	230.00	211.63	56,668.00	43,967.76	-0.22	52,385.22	-0.08
231.00	266.00	247.69	48,168.00	40,718.02	-0.15	49,088.49	0.02
267.00	296.00	280.81	43,015.00	31,914.89	-0.26	38,839.63	-0.10
297.00	320.00	307.89	35,028.00	24,409.96	-0.30	29,911.96	-0.15
STANDARD ERROR					0.242		0.204

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	3.71	3.78	
CURVE FIT WITH THE CALOT TECHNIQUE	1.37	3.78	

FIRST UNIT, LAST UNIT FOR PREDICT	321	344
PREDICTION WITH ELEMENTARY TECHNIQUE	23,531.39	
PREDICTION WITH CALOT TECHNIQUE	28,997.99	

T-38 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	18.45	18.45	18.52	0.00	18.42	-0.00
2.00	6.88	10.73	11.57	0.08	11.50	0.07
3.00	6.45	7.81	7.07	-0.09	7.03	-0.10
4.00	2.84	4.21	4.07	-0.03	4.06	-0.04
5.00	1.54	2.41	2.51	0.04	2.51	0.04
6.00	1.37	1.99	2.01	0.01	2.02	0.02
STANDARD ERROR				0.055		0.055

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	24.92	24.54
EXPONENT	-0.43	-0.43
SLOPE	74.33	74.48
R SQR	1.00	0.99
STD ERR EST	0.07	0.17

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	2.00	0.53	36.90	37.04	0.00	36.83	-0.00
3.00	6.00	3.74	27.50	32.39	0.18	32.19	0.17
7.00	19.00	11.62	83.90	64.81	-0.23	64.62	-0.23
20.00	69.00	40.26	142.20	146.46	0.03	146.56	0.03
70.00	213.00	131.50	222.20	254.15	0.14	255.17	0.15
214.00	357.00	280.56	196.90	183.80	-0.07	184.89	-0.06
STANDARD ERROR					0.135		0.135

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.68 F-TABLE 9.00 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.36 F-TABLE 9.00 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 358 494

PREDICTION WITH ELEMENTARY TECHNIQUE 146.71

PREDICTION WITH CALOT TECHNIQUE 147.74

T-39 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	2.84	2.84	2.84	-0.00	2.67	-0.06
2.00	1.58	2.38	2.43	0.02	2.55	0.07
3.00	3.19	2.43	2.38	-0.02	2.53	0.04
STANDARD ERROR				0.018		0.060

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	12.94	4.21
EXPONENT	-0.33	-0.10
SLOPE	79.32	93.29
R SQR	0.95	0.05
STD ERR EST	0.03	0.52

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	94.00	32.74	267.30	266.54	-0.00	250.95	-0.06
95.00	149.00	120.34	86.70	95.67	0.10	128.87	0.49
150.00	159.00	153.99	31.90	16.01	-0.50	22.86	-0.28
STANDARD ERROR					0.294		0.327

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.50	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.38	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	160	191
PREDICTION WITH ELEMENTARY TECHNIQUE	49.11	
PREDICTION WITH CALOT TECHNIQUE	72.23	

TF-30 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	2.27	2.27	2.26	-0.00	2.27	-0.00
2.00	2.17	2.19	2.21	0.01	2.21	0.01
3.00	2.21	2.20	2.18	-0.01	2.17	-0.01
4.00	2.09	2.14	2.15	0.00	2.14	0.00
STANDARD ERROR				0.008		0.009

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	2.39	2.41
EXPONENT	-0.01	-0.02
SLOPE	98.97	98.83
R SQR	0.92	0.85
STD ERR EST	0.01	0.02

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	39.00	14.22	88.60	88.31	-0.00	88.50	-0.00
40.00	172.00	97.64	288.30	292.61	0.01	292.14	0.01
173.00	536.00	337.10	804.20	786.15	-0.02	782.96	-0.03
537.00	1,120.00	810.05	1,219.70	1,244.88	0.02	1,237.70	0.01
STANDARD ERROR					0.017		0.017

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.00 F-TABLE 2.81 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.00 F-TABLE 2.81 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 1121 1613

PREDICTION WITH ELEMENTARY TECHNIQUE 1,042.81

PREDICTION WITH CALOT TECHNIQUE 1,035.74

TF-33 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	0.80	0.80	0.81	0.01	0.81	0.01
2.00	0.81	0.81	0.78	-0.03	0.78	-0.03
3.00	0.75	0.76	0.78	0.02	0.77	0.01
STANDARD ERROR				0.020		0.021

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	0.81	0.81
EXPONENT	-0.01	-0.01
SLOPE	99.58	99.45
R SQR	0.36	0.43
STD ERR EST	0.04	0.04

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	2.00	0.73	1.60	1.61	0.01	1.62	0.01
3.00	168.00	65.00	134.00	130.24	-0.03	129.51	-0.03
169.00	852.00	466.66	513.10	530.31	0.03	525.39	0.02
STANDARD ERROR					0.026		0.025

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.49	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.48	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	853	1146
PREDICTION WITH ELEMENTARY TECHNIQUE	226.90	
PREDICTION WITH CALOT TECHNIQUE	224.48	

TF-34 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	1.60	1.60	1.59	-0.01	1.57	-0.02
2.00	1.07	1.14	1.16	0.02	1.19	0.04
3.00	1.02	1.09	1.07	-0.02	1.10	0.01
STANDARD ERROR				0.018		0.028

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	2.31	2.21
EXPONENT	-0.15	-0.13
SLOPE	90.38	91.28
R SQR	0.99	0.96
STD ERR EST	0.03	0.07

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	13.00	4.44	20.80	20.69	-0.01	20.46	-0.02
14.00	111.00	53.14	105.30	108.50	0.03	111.25	0.06
112.00	204.00	154.85	95.30	88.07	-0.08	91.71	-0.04
STANDARD ERROR					0.047		0.040

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.50 F-TABLE 2.81 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.49 F-TABLE 2.81 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 205 309

PREDICTION WITH ELEMENTARY TECHNIQUE 92.48

PREDICTION WITH CALOT TECHNIQUE 96.99

TF-39 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	4.81	4.81	4.82	0.00	4.83	0.00
2.00	3.30	3.83	3.82	-0.00	3.82	-0.00
3.00	2.71	3.29	3.29	0.00	3.29	0.00
STANDARD ERROR				0.003		0.003

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	12.05	12.11
EXPONENT	-0.22	-0.22
SLOPE	85.74	85.66
R SQR	1.00	1.00
STD ERR EST	0.00	0.01

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	62.00	19.80	298.40	298.82	0.00	299.37	0.00
63.00	177.00	113.45	379.90	377.03	-0.01	376.02	-0.01
178.00	345.00	255.28	455.10	460.07	0.01	458.30	0.01
STANDARD ERROR					0.008		0.007

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.50	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.50	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	346	410
PREDICTION WITH ELEMENTARY TECHNIQUE	163.26	
PREDICTION WITH CALOT TECHNIQUE	162.54	

UH-1N 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	797.33	797.33	795.91	-0.00	782.83	-0.02
2.00	742.58	776.11	777.81	0.00	776.47	0.00
3.00	723.75	756.54	760.92	0.01	770.46	0.02
4.00	805.88	761.69	757.00	-0.01	769.05	0.01
STANDARD ERROR				0.004		0.014

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	976.94	841.78
EXPONENT	-0.05	-0.02
SLOPE	96.80	98.85
R SQR	0.98	0.54
STD ERR EST	0.01	0.06

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	79.00	28.82	62,989.00	62,876.60	-0.00	61,843.19	-0.02
80.00	129.00	102.97	37,129.00	37,460.74	0.01	38,321.78	0.03
130.00	206.00	165.98	55,729.00	56,411.92	0.01	58,549.21	0.05
207.00	230.00	217.87	19,341.00	17,359.74	-0.10	18,166.81	-0.06
STANDARD ERROR					0.052		0.044

	F-CALC	F-TABLE	(90%)
CURVE FIT WITH ELEMENTARY TECHNIQUE	0.00	2.81	
CURVE FIT WITH THE CALOT TECHNIQUE	0.00	2.81	

FIRST UNIT, LAST UNIT FOR PREDICT	231	257
PREDICTION WITH ELEMENTARY TECHNIQUE	19,428.68	
PREDICTION WITH CALOT TECHNIQUE	20,400.09	

UH-60 'S CUMULATIVE AVERAGE LEARNING CURVE
SUMMARY COST DATA

LOT	LOT AVG	CUM AVG	ET CUM AVG	%ERROR	CALOT CUM AVG	% ERROR
1.00	15,855.33	15,855.33	15,784.63	-0.00	15,748.02	-0.01
2.00	5,454.73	7,188.17	7,261.44	0.01	7,251.07	0.01
3.00	2,919.14	3,957.55	3,935.17	-0.01	3,949.07	-0.00
STANDARD ERROR				0.007		0.007

	FITTING WITH E.T.	FITTING WITH CALOT
FIRST UNIT	25,409.42	24,757.01
EXPONENT	-0.43	-0.43
SLOPE	74.05	74.36
R SQR	1.00	1.00
STD ERR EST	0.01	0.02

FIRST UNIT	LAST UNIT	LPP	LOT TOTAL	ET EST	% ERR	CA EST	% ERR
1.00	3.00	0.78	47,566.00	47,353.88	-0.00	47,244.06	-0.01
4.00	18.00	8.96	81,821.00	83,351.94	0.02	83,275.16	0.02
19.00	74.00	41.36	163,472.00	160,496.60	-0.02	161,711.60	-0.01
STANDARD ERROR					0.015		0.013

CURVE FIT WITH ELEMENTARY TECHNIQUE F-CALC 0.50 F-TABLE 2.81 (90%)

CURVE FIT WITH THE CALOT TECHNIQUE F-CALC 0.50 F-TABLE 2.81 (90%)

FIRST UNIT, LAST UNIT FOR PREDICT 75 166

PREDICTION WITH ELEMENTARY TECHNIQUE 169,074.50

PREDICTION WITH CALOT TECHNIQUE 171,199.80

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The technique used to fit cost data to the cumulative average learning curve can have an impact on the accuracy of the estimates provided. This research tested two specific fitting techniques, the elementary technique (ET) and the Calot technique, in an attempt to determine which technique provides the greater accuracy when used to fit historical lot cost data to the cumulative average learning curve. Both techniques were evaluated on there ability to fit total lot costs and predict last lot costs.

The ET and Calot fitting techniques were both used to fit the historical lot costs for 66 systems to the cumulative average learning curve. A comparison of the two techniques indicates that Calot estimates total lot costs with greater accuracy more frequently and with a significantly lower standard error than the ET technique. Calot also demonstrated the ability to estimate the last lot costs more accurately more frequently than 50% of the time.

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